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FLATHEAD RIVER BASIN
ENVIRONMENTAL IMPACT STUDY
AIR QUALITY MODELING ANALYSIS

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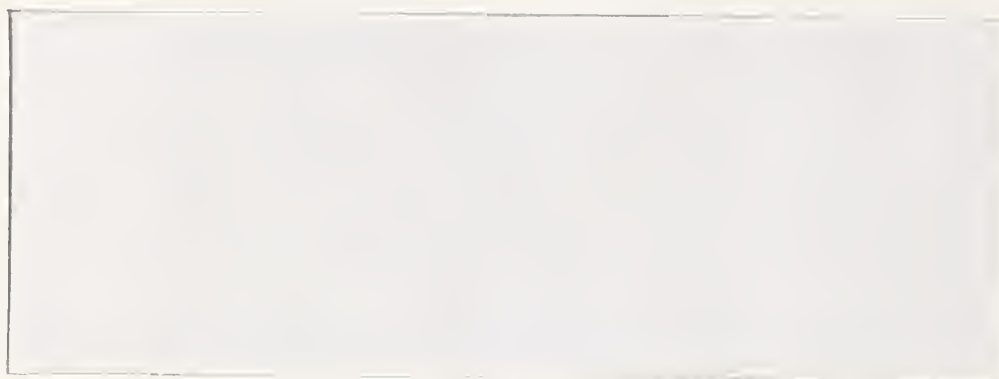
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FLATHEAD RIVER BASIN
ENVIRONMENTAL IMPACT STUDY
AIR QUALITY MODELING ANALYSIS

AUGUST 1983

PREPARED FOR
AIR QUALITY BUREAU
MONTANA DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
HELENA, MONTANA 59620

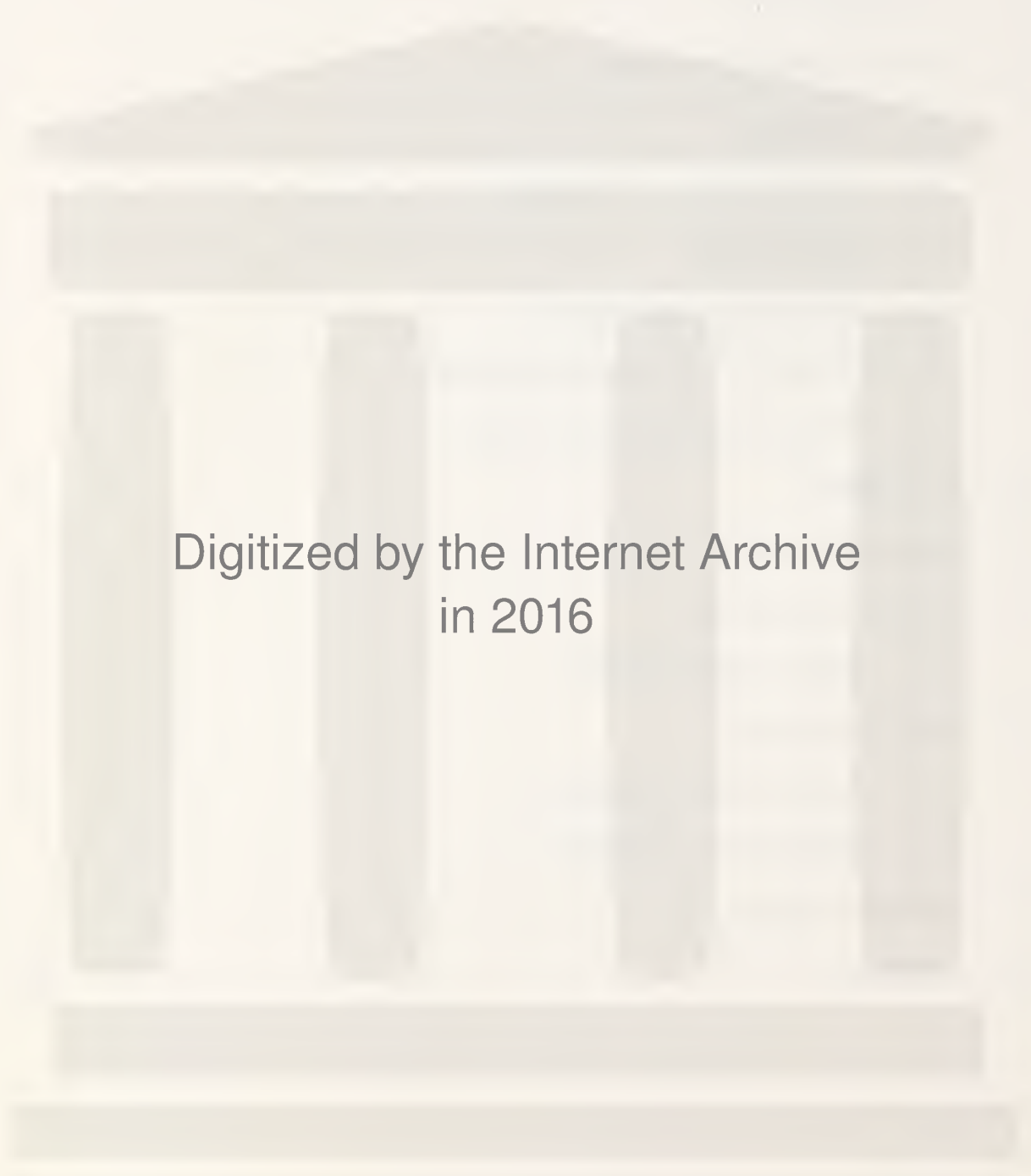
PREPARED BY
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FLATHEAD RIVER BASIN ENVIRONMENTAL IMPACT STUDY AIR QUALITY MODELING ANALYSIS

1.0 INTRODUCTION

Congress in 1977, recognizing a need to protect and to maintain a high environmental quality for the Flathead River Basin, directed the Environmental Protection Agency (EPA) to study environmental impacts of existing and proposed resource development in the Basin. The subsequent Flathead River Basin Environmental Impact Study was conceived through a coordinated effort among EPA, state and local government bodies, and interested individuals.

In 1978 the Montana Air Quality Bureau (AQB) was requested to assess the need for additional air quality studies in the Basin. The AQB then proposed five goals involving studies related to air quality assessments:

1. Quantify existing air quality in the Basin;
2. Quantify existing levels of air pollution sources;
3. Quantify the meteorology of the Basin;



4. Develop the capability to assess the effects of man's activities upon the air quality of the Basin; and
5. Develop guidelines to protect and to enhance the air quality of the Basin.

During 1978, the AQB initiated various air quality, meteorology, and visibility studies of the Basin. Also, an area source emission inventory was conducted during 1978-79 by Thomas Stewart. Goals 4 and 5 are the primary function for this report. The modeling analysis discussed in this report is designed to prepare the meteorological and emission inventory data in a form for modeling analysis, select airsheds and diffusion models best suited for the various areas, and to execute the model for both annual and twenty-four hour periods for the Basin.



2.0 METEOROLOGICAL DATA

2.1 Audits

As a method of assessing the meteorological data prior to selecting data periods for use in the diffusion models, Bison performed an audit of the meteorological data. A preliminary screening of the entire data base was conducted to narrow the data to that period of best data completeness. This was generally 15 months or greater for each of the monitoring sites. This preliminary screening was performed to decrease the time required to audit the data. Many of the monitoring sites operated for four years. After the data was screened into a reasonable period an audit was performed on the data. One Bison staff member read the actual wind and temperature strip charts for random hours through the period. These values were recorded on an audit form (Appendix A) for later comparison with the computer printout values. Once the strip chart reading portion of the audit was performed, the corresponding computer printout values were retrieved and recorded on the same forms. The values were compared against the strip chart values and a percent difference was calculated based on the following formula:

$$\frac{\text{Computer Value} - \text{Stripchart Value}}{\text{Stripchart Full Scale}} \times 100\%$$

These values were also recorded on the forms in Appendix A. Tables 2.1 through 2.5 summarize the average differences calculated in the audit. Differences less than 10 percent are considered acceptable. At most monitor sites the audits were



concentrated on pre-1982 data. The 1982 data was believed to be already well audited and reliable due to a more concentrated monitoring program and full-time field technicians. Prior to 1982 many of the sites were not audited. The Glacier International Airport site data was not audited in this report as the Air Quality Bureau felt this data was the most reliable due to the computer data acquisition system and periodic audits in the field.

2.2 Selection of Periods

Based on the audits and the data completeness, the preliminary data periods were narrowed to the best one-year periods for the six sites where wind data was measured. Based on subsection 2.3, variations in these one-year periods were made to allow the compilation of the most complete data sets. Table 2.6 lists the general data periods selected for each site.

2.3 Data Gaps

Each of the monitoring site meteorological data sets were reviewed day by day and missing or bad data was recorded. Review of each missing period was then made to determine if the gaps could be filled. Several methods were utilized in filling these gaps. These methods were:

1. Month replacement
2. Interpolation
3. Calm wind adjustment
4. Use of another monitoring site

Months that had extremely large missing periods (greater



than 50%) were marked for replacement. Previous years were reviewed to determine if better data completeness was recorded during the same month only during a different year. If this was the case, all parameters involved were replaced by the new month (wind speed, wind direction, temperature, stability, and mixing height). A second data gap filling method used was interpolation. If a day had two or less hours missing in a row, these values were replaced using an interpolation of the previous and following hours' values. The third method of data gap filling involved the calm winds. The standard Gaussian dispersion equation will not accept calm winds. Therefore, any wind speed less than 1.0 meters per second but greater than 0.0 meters per second was increased to 1.0. Wind speeds of 0.0 meters per second were assigned the previous hour wind speed and wind direction unless more than two hours were calm. The fourth data gap filling method was to utilize data from another monitoring site deemed representative of the site of concern. This most often was the case with temperature, stability, and mixing height data.

The appendix lists the individual hours of data missing for each data set used.

2.4 Percent Completion

Following the data gap review and filling, tables of final data recoveries were computed (Tables 2.7-2.11). These tables also show the various months that were substituted in Table 2.6 to allow more complete data bases. The tables also show the source of the data used. Especially of note are instances where



data from another monitoring site was used. The use of alternate monitoring sites was especially true for mixing height data which was available from only two sites.

2.5 Stability Frequency Decks

The final data sets were then input to a computer program that tallied the stability, wind speed, and wind direction data into stability frequency decks (commonly called STAR decks). The STAR decks list the data in percent frequencies of six wind speed categories versus sixteen wind direction intervals for each of six stability classifications. Tables 2.12 through 2.16 list the STAR decks for the various monitoring sites.

2.6 Preprocessed Data Decks

Similarly to the STAR decks, the hourly meteorological data was processed through a computer program to prepare the hourly data for entry into short-term diffusion models such as CRSTER and ISC. The preprocessed data decks are not listed due to the extreme length of the data sets. However, magnetic tape copies of each data set were supplied as an addendum to this report.



TABLE 2.1
AVERAGE AUDIT DIFFERENCE*
COLUMBIA FALLS

Parameter			
<u>Month</u>	<u>Wind Speed</u>	<u>Wind Direction</u>	<u>Temperature</u>
Mar/78	-0.75	-0.25	--
Apr	1.59	0	--
May	0	-0.91	--
Jun	1.49	2.93	--
Jul	0	-1.15	--
Aug	0.13	3.09	--
Sep	-0.56	-0.41	--
Oct	-0.35	-2.03	--
Nov	0.63	2.01	--
Dec	1.71	0.02	--
Jan/79	-0.13	8.73	--
Feb	0.90	-1.44	--
Mar	-0.44	2.78	--
Apr	-0.40	0	--
May	0.23	3.45	--
Jun	0.70	-6.11	--
Jul	-0.36	2.02	--
Aug	-0.68	4.0	--
Sep	0.20	3.4	--
Oct	0.36	-1.14	--

*Values equal to monthly average of:

$$\frac{\text{Audit Reading} - \text{Computer Reading}}{\text{Chart Full Scale}} \times 100\%$$



TABLE 2.2
AVERAGE AUDIT DIFFERENCE*
BIG FORK

Parameter			
<u>Month</u>	<u>Wind Speed</u>	<u>Wind Direction</u>	<u>Temperature</u>
Jul/81	0.10	0.56	--
Aug	0.08	-0.90	0
Sep	0.30	4.65	0
Oct	0.08	1.50	1
Nov	0.14	5.0	0.40
Dec	0.24	0.66	0.40
Jan/82	0.16	1.5	0
Feb	0.40	2.5	-0.33

*Values equal to monthly average of:

$$\frac{\text{Audit Reading} - \text{Computer Reading}}{\text{Chart Full Scale}} \times 100\%$$



TABLE 2.3
AVERAGE AUDIT DIFFERENCE*
BIG PRAIRIE

Parameter			
<u>Month</u>	<u>Wind Speed</u>	<u>Wind Direction</u>	<u>Temperature</u>
Mar/81	-0.08	0	--
Apr	-0.08	0.49	--
May	-0.23	-1.61	--
Jun	0.03	-0.95	--
Jul	0	0	--
Aug	-0.20	0	--
Sep	0	0	--
Oct	--	-9.31	--
Nov	3.50	0	--
Dec	0	--	--
Jul/80	0.01	0.49	--
Aug	2.00	1.82	--
Sep	-0.35	-0.72	--
Oct	0.95	0	--
Nov	-0.01	0.87	--

*Values equal to monthly average of:

$$\frac{\text{Audit Reading} - \text{Computer Reading}}{\text{Chart Full Scale}} \times 100\%$$



TABLE 2.4
AVERAGE AUDIT DIFFERENCE*

NINEPIPE

Parameter

<u>Month</u>	<u>Wind Speed</u>	<u>Wind Direction</u>	<u>Temperature</u>
Aug/81	-0.10	-8.06	--
Sep	-0.70	0.56	--
Oct	-0.73	-4.86	--
Nov	-0.76	-2.72	--
Dec	-0.04	-5.11	--
Jan/82	--	--	--
Feb	-0.22	-2.06	--
Mar	-0.20	3.44	--

*Values equal to monthly average of:

$$\frac{\text{Audit Reading} - \text{Computer Reading}}{\text{Chart Full Scale}} \times 100\%$$

Chart Full Scale



TABLE 2.5
AVERAGE AUDIT DIFFERENCE*
POLSON

Parameter			
<u>Month</u>	<u>Wind Speed</u>	<u>Wind Direction</u>	<u>Temperature</u>
Mar/81	0.13	-0.80	0
Apr	0.23	0.29	1.19
May	0.25	2.81	-0.40
Jun	-0.10	0.63	-0.03
Jul	-0.20	0	0
Aug	0	0	0
Sep	0	2.50	-0.20
Oct	-0.60	0	0
Nov	0.40	1.28	-0.80
Dec	0	--	0

*Values equal to monthly average of:

$$\frac{\text{Audit Reading} - \text{Computer Reading}}{\text{Chart Full Scale}} \times 100\%$$

TABLE 2.6
GENERAL METEOROLOGICAL DATA PERIODS

<u>Monitoring Site</u>	<u>Date Period</u>
Glacier International Airport	Dec. 1979 - Nov. 1980
Ninepipe	Mar. 1981 - Feb. 1982
Polson	Mar. 1981 - Feb. 1982
Columbia Falls	Sep. 1978 - Aug. 1979
Bigfork	Jul. 1981 - Jun. 1982
Big Prairie (N. Fk. Flathead R.)	Mar. 1981 - Feb. 1982



TABLE 2.7

METEOROLOGICAL DATA RECOVERY AND SOURCE

Columbia Falls (CF)

Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source
Sep/78	100	CF	100	CF	100	GIA	100	GIA	100	GIA
Oct/78	97	CF	100	CF	99	GIA	61	GIA	100	GIA
Nov/78	77	CF	77	CF	100	GIA	100	GIA	100	GIA
Dec/78	45	CF	64	CF	100	GIA	100	GIA	100	GIA
Jan/79	91	CF	76	CF	100	GIA	97	NWS*	100	GIA
Feb/79	100	CF	100	CF	100	GIA	46	GIA	100	GIA
Mar/79	100	CF	100	CF	100	GIA	20	NWS	100	GIA
Apr/79	100	CF	97	CF	99	GIA	100	GIA	100	GIA
May/79	100	CF	100	CF	100	GIA	100	NWS	100	GIA
Jun/79	100	CF	100	CF	99	GIA	68	GIA	100	GIA
Jul/79	87	CF	90	CF	100	GIA	100	GIA	100	GIA
Aug/79	78	CF	78	CF	100	GIA	65	GIA	100	GIA

*NWS = Kalispell National Weather Service

TABLE 2.8

METEOROLOGICAL DATA RECOVERY AND SOURCE

Big Prairie (BP)

Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source
Nov/78 (Jan)	68	BP	68	BP	97	GIA	97	GIA	100	GIA
Dec/78 (Feb)	39	BP	34	BP	100	GIA	100	GIA	100	GIA
Mar/81	58	BP	37	BP	47	GIA	100	GIA	100	GIA
Apr/81	85	BP	75	BP	100	GIA	100	GIA	100	GIA
May/81	99	BP	72	BP	100	GIA	100	GIA	100	GIA
Jun/81	99	BP	87	BP	100	GIA	100	GIA	100	GIA
Jul/81	100	BP	81	BP	94	GIA	90	GIA	100	GIA
Aug/81	95	BP	73	BP	100	GIA	100	GIA	100	GIA
Sep/81	98	BP	58	BP	81	GIA	100	GIA	100	GIA
Oct/80	74	BP	79	BP	100	GIA	100	GIA	100	GIA
Nov/78	68	BP	68	BP	100	GIA	100	GIA	100	GIA
Dec/78	32	BP	32	BP	100	GIA	100	GIA	100	GIA

TABLE 2.9

METEOROLOGICAL DATA RECOVERY AND SOURCE

Ninepipe (NIN)

Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source
Mar/81	100	NIN	100	NIN	70	NIN	84	NIN	100	NIN
Apr/81	98	NIN	100	NIN	52	NIN	80	NIN	100	NIN
May/81	100	NIN	99	NIN	59	NIN	100	NIN	100	NIN
Jun/81	99	NIN	97	NIN	98	NIN	88	NIN	100	NIN
Jul/81	100	NIN	99	NIN	100	NIN	83	NIN	100	NIN
Aug/81	86	NIN	86	NIN	73	NIN	81	NIN	100	NIN
Sep/81	50	NIN	50	NIN	97	NIN	97	NIN	100	NIN
Oct/81	71	NIN	770	NIN	87	NIN	97	NIN	100	NIN
Nov/81	96	NIN	96	NIN	100	NIN	67	NIN	100	NIN
Dec/81	100	NIN	100	NIN	16	NIN	92	NIN	100	NIN
Jan/82	100	NIN	97	NIN	97	NIN	37	NIN	100	NIN
Feb/82	100	NIN	100	NIN	100	NIN	100	NIN	100	NIN

TABLE 2.10

METEOROLOGICAL DATA RECOVERY AND SOURCE

Polson (POL)

Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source
Mar/81	71	POL	69	POL	70	NIN	84	NIN	100	NIN
Apr/81	68	POL	68	POL	52	NIN	80	NIN	100	NIN
May/81	81	POL	82	POL	59	NIN	100	NIN	100	NIN
Jun/81	98	POL	98	POL	98	NIN	88	NIN	100	NIN
Jul/81	100	POL	100	POL	100	NIN	83	NIN	100	NIN
Aug/81	62	POL	74	POL	73	NIN	81	NIN	100	NIN
Sep/81	92	POL	97	POL	97	NIN	97	NIN	100	NIN
Oct/81	85	POL	87	POL	187	NIN	97	NIN	100	NIN
Nov/81	100	POL	97	POL	100	NIN	67	NIN	100	NIN
Dec/81	51	POL	55	POL	16	NIN	92	NIN	100	NIN
Jan/82	100	POL	97	POL	97	NIN	37	NIN	100	NIN
Feb/82	100	POL	100	POL	100	NIN	100	NIN	100	NIN

TABLE 2.11

METEOROLOGICAL DATA RECOVERY AND SOURCE

Glacier International Airport (GIA)

Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source	Recovery (%)	Source
Jan/80	100	GIA	100	GIA	97	GIA/NWS*	97	GIA	100	GIA
Feb/80	100	GIA	100	GIA	100	GIA	86	GIA	100	GIA
Mar/80	91	GIA	91	GIA	100	GIA/NWS	90	NWS	100	GIA
Apr/80	100	GIA	100	GIA	100	GIA	100	GIA	100	GIA
May/80	100	GIA	100	GIA	100	GIA	81	GIA	100	GIA
Jun/80	99	GIA	99	GIA	99	GIA	67	GIA	100	GIA
Jul/80	100	GIA	100	GIA	100	GIA	91	GIA	100	GIA
Aug/80	100	GIA	100	GIA	100	GIA	100	GIA	100	GIA
Sep/80	100	GIA	100	GIA	74	GIA	100	GIA	100	GIA
Oct/80	97	GIA	98	GIA	100	NWS	99	GIA	100	GIA
Nov/80	84	GIA	85	GIA	100	GIA	83	GIA	100	GIA
Dec/79	100	GIA	100	GIA	100	GIA	100	GIA	100	GIA

*NWS = Kalispell National Weather Service

TABLE 2.12

METEOROLOGICAL DATA RECOVERY AND SOURCE

Bigfork (BF) Monitoring Site

Month/Year	Wind Speed		Wind Direction		Temperature		Stability		Mixing Height	
	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source	Recovery(%)	Source
Jan/82	100	BF	99	BF	100	BF	100	GIA	100	GIA
Feb/82	74	BF	76	BF	74	BF	98	GIA	100	GIA
Mar/82	93	BF	93	BF	88	BF	100	GIA	100	GIA
Apr/82	32	BF	35	BF	32	BF	100	GIA	100	GIA
May/82	100	BF	79	BF	100	BF	100	GIA	100	GIA
Jun/82	52	BF	0	BF	52	BF	92	GIA	100	GIA
Jul/81	31	BF	35	BF	100	NWS	90	GIA	100	GIA
Aug/81	94	BF	94	BF	94	BF	100	GIA	100	GIA
Sep/81	74	BF	74	BF	74	BF	100	GIA	100	GIA
Oct/81	100	BF	100	BF	100	BF	100	GIA	100	GIA
Nov/81	100	BF	100	BF	100	BF	100	GIA	100	GIA
Dec/81	100	BF	100	BF	100	BF	100	GIA	100	GIA

*NWS = Kalispell National Weather Service

TABLE 2.13

STABILITY FREQUENCY PERCENTAGES

Columbia Falls

Monitoring Site

STABILITY CLASS A

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
S	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.002329	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000499	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000832	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000499	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.001663	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.001164	0.000000	0.000000	0.000000	0.000000	0.000000
S	0.000665	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000333	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000166	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.002994	0.000166	0.000000	0.000000	0.000000	0.000000
NNW	0.004158	0.000000	0.000000	0.000000	0.000000	0.000000



TABLE 2.13
(cont.)

STABILITY FREQUENCY PERCENTAGES

Columbia Falls

Monitoring Site

STABILITY CLASS C

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.012808	0.001830	0.000000	0.000000	0.000000	0.000000
NNE	0.003493	0.002661	0.000166	0.000000	0.000000	0.000000
NE	0.001996	0.003327	0.000832	0.000000	0.000000	0.000000
ENE	0.000832	0.005655	0.000166	0.000000	0.000000	0.000000
E	0.000499	0.006154	0.000333	0.000000	0.000000	0.000000
ESE	0.001164	0.001663	0.000000	0.000000	0.000000	0.000000
SE	0.004657	0.001497	0.000000	0.000000	0.000000	0.000000
SSE	0.009647	0.002329	0.000000	0.000000	0.000000	0.000000
S	0.022621	0.010812	0.000000	0.000000	0.000000	0.000000
SSW	0.006653	0.002162	0.000000	0.000000	0.000000	0.000000
SW	0.002828	0.000665	0.000000	0.000000	0.000000	0.000000
WSW	0.001996	0.000499	0.000000	0.000000	0.000000	0.000000
W	0.002162	0.000832	0.000000	0.000000	0.000000	0.000000
WNW	0.002661	0.001830	0.000000	0.000000	0.000000	0.000000
NW	0.016301	0.002994	0.000000	0.000000	0.000000	0.000000
NNW	0.041417	0.002495	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS D

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.028776	0.006986	0.000665	0.000000	0.000000	0.000000
NNE	0.008649	0.005323	0.004824	0.000166	0.000000	0.000000
NE	0.008649	0.006986	0.004824	0.002329	0.000000	0.000000
ENE	0.009980	0.007152	0.003992	0.002495	0.000000	0.000000
E	0.010645	0.007152	0.005655	0.001331	0.000000	0.000000
ESE	0.007152	0.001497	0.000499	0.000166	0.000000	0.000000
SE	0.014970	0.001497	0.000000	0.000000	0.000000	0.000000
SSE	0.028776	0.008982	0.000166	0.000000	0.000000	0.000000
S	0.038922	0.024784	0.000000	0.000000	0.000000	0.000000
SSW	0.012641	0.003493	0.000000	0.000000	0.000000	0.000000
SW	0.009814	0.000832	0.000000	0.000000	0.000000	0.000000
WSW	0.014471	0.000832	0.000000	0.000000	0.000000	0.000000
W	0.015469	0.000166	0.000000	0.000000	0.000000	0.000000
WNW	0.011144	0.001830	0.000000	0.000000	0.000000	0.000000
NW	0.069860	0.006154	0.000000	0.000000	0.000000	0.000000
NNW	0.054890	0.005988	0.000333	0.000000	0.000000	0.000000



TABLE 2.13
(cont.)

STABILITY FREQUENCY PERCENTAGES

Columbia Falls

Monitoring Site

STABILITY CLASS E

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.010479	0.001164	0.000000	0.000000	0.000000	0.000000
NNE	0.001830	0.001497	0.000000	0.000000	0.000000	0.000000
NE	0.001996	0.000499	0.000000	0.000000	0.000000	0.000000
ENE	0.004158	0.002495	0.000166	0.000000	0.000000	0.000000
E	0.003327	0.002661	0.001164	0.000000	0.000000	0.000000
ESE	0.001497	0.000166	0.000000	0.000000	0.000000	0.000000
SE	0.003327	0.000333	0.000000	0.000000	0.000000	0.000000
SSE	0.006154	0.000333	0.000000	0.000000	0.000000	0.000000
S	0.011477	0.006321	0.000000	0.000000	0.000000	0.000000
SSW	0.006820	0.001663	0.000000	0.000000	0.000000	0.000000
SW	0.004158	0.001164	0.000000	0.000000	0.000000	0.000000
WSW	0.009315	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.006154	0.000665	0.000000	0.000000	0.000000	0.000000
WNW	0.004325	0.000998	0.000000	0.000000	0.000000	0.000000
NW	0.015802	0.000333	0.000000	0.000000	0.000000	0.000000
NNW	0.023952	0.001164	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.013972	0.002495	0.000166	0.000000	0.000000	0.000000
NNE	0.003992	0.002329	0.000000	0.000000	0.000000	0.000000
NE	0.001164	0.004325	0.001663	0.000000	0.000000	0.000000
ENE	0.001996	0.005156	0.002329	0.000000	0.000000	0.000000
E	0.002994	0.005156	0.000832	0.000166	0.000000	0.000000
ESE	0.001497	0.000665	0.000166	0.000000	0.000000	0.000000
SE	0.004325	0.000166	0.000000	0.000000	0.000000	0.000000
SSE	0.012142	0.000665	0.000000	0.000000	0.000000	0.000000
S	0.022122	0.008816	0.000000	0.000000	0.000000	0.000000
SSW	0.006820	0.001830	0.000000	0.000000	0.000000	0.000000
SW	0.005323	0.000665	0.000000	0.000000	0.000000	0.000000
WSW	0.003493	0.000166	0.000000	0.000000	0.000000	0.000000
W	0.003327	0.000832	0.000000	0.000000	0.000000	0.000000
WNW	0.007319	0.000998	0.000000	0.000000	0.000000	0.000000
NW	0.021291	0.004491	0.000000	0.000000	0.000000	0.000000
NNW	0.046075	0.001331	0.000000	0.000000	0.000000	0.000000



TABLE 2.14

STABILITY FREQUENCY PERCENTAGES

Big Prairie

Monitoring Site

STABILITY CLASS A

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.001480	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000000	0.000185	0.000000	0.000000	0.000000	0.000000
E	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000185	0.000370	0.000000	0.000000	0.000000	0.000000
SSE	0.000185	0.000370	0.000000	0.000000	0.000000	0.000000
S	0.000000	0.000185	0.000000	0.000000	0.000000	0.000000
SSW	0.000185	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000185	0.000000	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.005733	0.000370	0.000000	0.000000	0.000000	0.000000
NNE	0.001665	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.001110	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.001295	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000370	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.001295	0.000185	0.000000	0.000000	0.000000	0.000000
SE	0.002034	0.000370	0.000000	0.000000	0.000000	0.000000
SSE	0.001849	0.000370	0.000000	0.000000	0.000000	0.000000
S	0.000740	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000555	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.001295	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000555	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000555	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.002959	0.000000	0.000000	0.000000	0.000000	0.000000



TABLE 2.14
(cont.)

STABILITY FREQUENCY PERCENTAGES

Big Prairie

Monitoring Site

STABILITY CLASS C

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.031256	0.001480	0.000370	0.000000	0.000000	0.000000
NNE	0.007398	0.000370	0.000000	0.000000	0.000000	0.000000
NE	0.008323	0.000185	0.000000	0.000000	0.000000	0.000000
ENE	0.003699	0.000370	0.000000	0.000000	0.000000	0.000000
E	0.005548	0.000925	0.000000	0.000000	0.000000	0.000000
ESE	0.003884	0.001295	0.000000	0.000000	0.000000	0.000000
SE	0.005733	0.004994	0.000000	0.000000	0.000000	0.000000
SSE	0.010172	0.008138	0.000000	0.000000	0.000000	0.000000
S	0.006658	0.001849	0.000000	0.000000	0.000000	0.000000
SSW	0.002034	0.001480	0.000000	0.000000	0.000000	0.000000
SW	0.003329	0.000925	0.000000	0.000000	0.000000	0.000000
WSW	0.001480	0.001665	0.000000	0.000000	0.000000	0.000000
W	0.001110	0.001849	0.000000	0.000000	0.000000	0.000000
WNW	0.001849	0.000370	0.000000	0.000000	0.000000	0.000000
NW	0.006288	0.002774	0.000000	0.000000	0.000000	0.000000
NNW	0.021454	0.003144	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS D

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.060292	0.030701	0.005548	0.000370	0.000000	0.000000
NNE	0.019974	0.000925	0.002034	0.000000	0.000000	0.000000
NE	0.019604	0.000925	0.002219	0.000555	0.000000	0.000000
ENE	0.005733	0.001110	0.000555	0.000000	0.000000	0.000000
E	0.004809	0.000740	0.000185	0.000000	0.000000	0.000000
ESE	0.005918	0.001480	0.000000	0.000000	0.000000	0.000000
SE	0.009802	0.003329	0.000000	0.000000	0.000000	0.000000
SSE	0.015720	0.005918	0.000000	0.000000	0.000000	0.000000
S	0.012391	0.010542	0.000000	0.000000	0.000000	0.000000
SSW	0.012576	0.006103	0.000000	0.000000	0.000000	0.000000
SW	0.012576	0.006103	0.000000	0.000185	0.000000	0.000000
WSW	0.003884	0.002404	0.000000	0.000000	0.000000	0.000000
W	0.005733	0.004439	0.000000	0.000000	0.000000	0.000000
WNW	0.006103	0.004994	0.000000	0.000000	0.000000	0.000000
NW	0.016830	0.007953	0.000000	0.000000	0.000000	0.000000
NNW	0.027002	0.007583	0.000000	0.000000	0.000000	0.000000



TABLE 2.14
(cont.)

STABILITY FREQUENCY PERCENTAGES

Big Prairie

Monitoring Site

STABILITY CLASS E

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.053634	0.009987	0.002219	0.000185	0.000000	0.000000
NNE	0.015720	0.000925	0.000000	0.000000	0.000000	0.000000
NE	0.013316	0.000740	0.000000	0.000000	0.000000	0.000000
ENE	0.007213	0.002589	0.000000	0.000000	0.000000	0.000000
E	0.004439	0.001849	0.000000	0.000000	0.000000	0.000000
ESE	0.005363	0.001295	0.000000	0.000000	0.000000	0.000000
SE	0.010357	0.005363	0.000000	0.000000	0.000000	0.000000
SSE	0.017940	0.020159	0.000000	0.000000	0.000000	0.000000
S	0.014241	0.009802	0.000000	0.000000	0.000000	0.000000
SSW	0.007768	0.005363	0.000000	0.000000	0.000000	0.000000
SW	0.009617	0.006843	0.000000	0.000000	0.000000	0.000000
WSW	0.002589	0.006843	0.000000	0.000000	0.000000	0.000000
W	0.003699	0.007583	0.000000	0.000000	0.000000	0.000000
WNW	0.005548	0.006473	0.000000	0.000000	0.000000	0.000000
NW	0.013131	0.014426	0.000000	0.000000	0.000000	0.000000
NNW	0.028482	0.008323	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.028482	0.002219	0.000185	0.000000	0.000000	0.000000
NNE	0.003329	0.000185	0.000000	0.000000	0.000000	0.000000
NE	0.003514	0.000370	0.000000	0.000000	0.000000	0.000000
ENE	0.002034	0.000740	0.000000	0.000000	0.000000	0.000000
E	0.002589	0.000925	0.000000	0.000000	0.000000	0.000000
ESE	0.002959	0.001110	0.000000	0.000000	0.000000	0.000000
SE	0.004624	0.003514	0.000000	0.000000	0.000000	0.000000
SSE	0.009802	0.008507	0.000000	0.000000	0.000000	0.000000
S	0.007768	0.005918	0.000000	0.000000	0.000000	0.000000
SSW	0.005363	0.003329	0.000000	0.000000	0.000000	0.000000
SW	0.004994	0.003514	0.000000	0.000000	0.000000	0.000000
WSW	0.002034	0.003699	0.000000	0.000000	0.000000	0.000000
W	0.001665	0.005733	0.000000	0.000000	0.000000	0.000000
WNW	0.003329	0.006843	0.000000	0.000000	0.000000	0.000000
NW	0.005363	0.002774	0.000000	0.000000	0.000000	0.000000
NNW	0.010357	0.003329	0.000000	0.000000	0.000000	0.000000



TABLE 2.15

STABILITY FREQUENCY PERCENTAGES

Glacier International Airport

Monitoring Site

STABILITY CLASS A

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000125	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000125	0.000125	0.000000	0.000000	0.000000	0.000000
SSE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
S	0.000375	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000125	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000125	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.001627	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000876	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000626	0.000125	0.000250	0.000000	0.000000	0.000000
ENE	0.001001	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000125	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000626	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000626	0.000125	0.000000	0.000000	0.000000	0.000000
SSE	0.001376	0.000000	0.000000	0.000000	0.000000	0.000000
S	0.000626	0.000125	0.000000	0.000000	0.000000	0.000000
SSW	0.000751	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.001376	0.000125	0.000000	0.000000	0.000000	0.000000
WSW	0.001126	0.000125	0.000000	0.000000	0.000000	0.000000
W	0.000751	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.002252	0.000250	0.000000	0.000000	0.000000	0.000000
NW	0.001877	0.000250	0.000000	0.000000	0.000000	0.000000
NNW	0.000876	0.000125	0.000000	0.000000	0.000000	0.000000



TABLE 2.15
(cont.)

STABILITY FREQUENCY PERCENTAGES

Glacier International Airport

Monitoring Site

STABILITY CLASS C

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.006006	0.005005	0.000000	0.000000	0.000000	0.000000
NNE	0.004880	0.004880	0.000375	0.000000	0.000000	0.000000
NE	0.003253	0.001251	0.000000	0.000000	0.000000	0.000000
ENE	0.001752	0.000250	0.000000	0.000000	0.000000	0.000000
E	0.001502	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.001877	0.000125	0.000000	0.000000	0.000000	0.000000
SE	0.006131	0.006507	0.000125	0.000000	0.000000	0.000000
SSE	0.009134	0.009009	0.000000	0.000000	0.000000	0.000000
S	0.005506	0.002002	0.000000	0.000000	0.000000	0.000000
SSW	0.004004	0.001627	0.000125	0.000000	0.000000	0.000000
SW	0.002252	0.001251	0.000000	0.000000	0.000000	0.000000
WSW	0.003003	0.000501	0.000375	0.000000	0.000000	0.000000
W	0.004254	0.000375	0.000000	0.000000	0.000000	0.000000
WNW	0.005130	0.000375	0.000000	0.000000	0.000000	0.000000
NW	0.006256	0.002002	0.000000	0.000000	0.000000	0.000000
NNW	0.004755	0.002503	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS D

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.013514	0.008509	0.001376	0.000250	0.000000	0.000000
NNE	0.010010	0.017392	0.000375	0.000000	0.000000	0.000000
NE	0.006632	0.002878	0.000250	0.000000	0.000000	0.000000
ENE	0.004505	0.001001	0.000000	0.000000	0.000000	0.000000
E	0.002753	0.000250	0.000000	0.000000	0.000000	0.000000
ESE	0.004254	0.000501	0.000000	0.000000	0.000000	0.000000
SE	0.007633	0.013388	0.000250	0.000000	0.000000	0.000000
SSE	0.020145	0.015390	0.000000	0.000000	0.000000	0.000000
S	0.019394	0.006381	0.000125	0.000000	0.000000	0.000000
SSW	0.013639	0.005380	0.000125	0.000000	0.000000	0.000000
SW	0.011261	0.005130	0.000250	0.000000	0.000000	0.000000
WSW	0.009134	0.003504	0.000000	0.000000	0.000000	0.000000
W	0.007633	0.001376	0.000000	0.000000	0.000000	0.000000
WNW	0.010260	0.001001	0.000000	0.000000	0.000000	0.000000
NW	0.013764	0.002377	0.000000	0.000000	0.000000	0.000000
NNW	0.014264	0.003754	0.000000	0.000000	0.000000	0.000000



TABLE 2.15
(cont.)

STABILITY FREQUENCY PERCENTAGES

Glacier International Airport

Monitoring Site

STABILITY CLASS E

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.031406	0.007257	0.000876	0.000000	0.000000	0.000000
NNE	0.026527	0.012638	0.001126	0.000000	0.000000	0.000000
NE	0.013764	0.001502	0.000250	0.000000	0.000000	0.000000
ENE	0.007508	0.000250	0.000000	0.000000	0.000000	0.000000
E	0.006006	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.008509	0.000501	0.000000	0.000000	0.000000	0.000000
SE	0.019770	0.011011	0.000250	0.000000	0.000000	0.000000
SSE	0.046922	0.022147	0.000375	0.000000	0.000000	0.000000
S	0.035035	0.008008	0.000000	0.000000	0.000000	0.000000
SSW	0.034159	0.008759	0.000375	0.000000	0.000000	0.000000
SW	0.025776	0.009760	0.000626	0.000000	0.000000	0.000000
WSW	0.016517	0.005255	0.000501	0.000000	0.000000	0.000000
W	0.018143	0.001502	0.000000	0.000000	0.000000	0.000000
WNW	0.021522	0.001376	0.000000	0.000000	0.000000	0.000000
NW	0.026026	0.003003	0.000125	0.000000	0.000000	0.000000
NNW	0.029404	0.003128	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.007758	0.001376	0.000000	0.000000	0.000000	0.000000
NNE	0.005255	0.001502	0.000125	0.000000	0.000000	0.000000
NE	0.003754	0.000751	0.000000	0.000000	0.000000	0.000000
ENE	0.002252	0.000250	0.000000	0.000000	0.000000	0.000000
E	0.001502	0.000125	0.000000	0.000000	0.000000	0.000000
ESE	0.001877	0.000375	0.000000	0.000000	0.000000	0.000000
SE	0.002753	0.004254	0.000000	0.000000	0.000000	0.000000
SSE	0.008258	0.010135	0.000000	0.000000	0.000000	0.000000
S	0.008759	0.003253	0.000000	0.000000	0.000000	0.000000
SSW	0.006757	0.002377	0.000250	0.000000	0.000000	0.000000
SW	0.007758	0.004254	0.000250	0.000000	0.000000	0.000000
WSW	0.007508	0.001627	0.000125	0.000000	0.000000	0.000000
W	0.008759	0.001001	0.000000	0.000000	0.000000	0.000000
WNW	0.010761	0.000501	0.000000	0.000000	0.000000	0.000000
NW	0.015265	0.000626	0.000000	0.000000	0.000000	0.000000
NNW	0.012387	0.000501	0.000000	0.000000	0.000000	0.000000



TABLE 2.16
STABILITY FREQUENCY PERCENTAGES
Ninepipe
Monitoring Site

STABILITY CLASS A

WINDSPEED CATEGORIES IN M/SEC

N	0.000912	0.000304	0.000152	0.000000	0.000000	0.000000
NNE	0.000760	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000760	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000456	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000456	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.001369	0.000152	0.000000	0.000000	0.000000	0.000000
SSE	0.000760	0.000152	0.000000	0.000000	0.000000	0.000000
S	0.001217	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000152	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000304	0.000152	0.000000	0.000000	0.000000	0.000000
WSW	0.000456	0.000152	0.000000	0.000000	0.000000	0.000000
W	0.000304	0.000304	0.000000	0.000000	0.000000	0.000000
WNW	0.000760	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.001064	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000456	0.000000	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

WINDSPEED CATEGORIES IN M/SEC

N	0.003650	0.000608	0.000000	0.000000	0.000000	0.000000
NNE	0.002129	0.000152	0.000000	0.000000	0.000000	0.000000
NE	0.001825	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.001825	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.002433	0.000152	0.000000	0.000000	0.000000	0.000000
ESE	0.001673	0.000152	0.000000	0.000000	0.000000	0.000000
SE	0.004410	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.006387	0.000760	0.000000	0.000000	0.000000	0.000000
S	0.003345	0.000608	0.000000	0.000000	0.000000	0.000000
SSW	0.001977	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.002129	0.000304	0.000000	0.000000	0.000000	0.000000
WSW	0.001825	0.001064	0.000000	0.000000	0.000000	0.000000
W	0.001521	0.000456	0.000000	0.000000	0.000000	0.000000
WNW	0.002585	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.002585	0.000304	0.000000	0.000000	0.000000	0.000000
NNW	0.003041	0.000152	0.000000	0.000000	0.000000	0.000000



TABLE 2.16 (cont.)

STABILITY FREQUENCY PERCENTAGES

Ninepipe

Monitoring Site

STABILITY CLASS C

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.007908	0.002129	0.000000	0.000000	0.000000	0.000000
NNE	0.003193	0.000912	0.000000	0.000000	0.000000	0.000000
NE	0.005779	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.003650	0.000304	0.000000	0.000000	0.000000	0.000000
E	0.002889	0.000608	0.000000	0.000000	0.000000	0.000000
ESE	0.006387	0.000304	0.000000	0.000000	0.000000	0.000000
SE	0.006843	0.002281	0.000000	0.000000	0.000000	0.000000
SSE	0.010341	0.004714	0.000000	0.000000	0.000000	0.000000
S	0.007299	0.004562	0.000304	0.000000	0.000000	0.000000
SSW	0.003954	0.000760	0.000000	0.000000	0.000000	0.000000
SW	0.002889	0.001369	0.000000	0.000000	0.000000	0.000000
WSW	0.003498	0.003802	0.000304	0.000000	0.000000	0.000000
W	0.003498	0.002129	0.000000	0.000000	0.000000	0.000000
WNW	0.002281	0.000760	0.000000	0.000000	0.000000	0.000000
NW	0.003498	0.000152	0.000000	0.000000	0.000000	0.000000
NNW	0.003954	0.000304	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS D

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.010949	0.002433	0.000000	0.000000	0.000000	0.000000
NNE	0.009884	0.001673	0.000000	0.000000	0.000000	0.000000
NE	0.007451	0.000456	0.000000	0.000000	0.000000	0.000000
ENE	0.008516	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.009732	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.012622	0.001521	0.000000	0.000000	0.000000	0.000000
SE	0.016880	0.002737	0.000152	0.000000	0.000000	0.000000
SSE	0.025395	0.011709	0.000000	0.000000	0.000000	0.000000
S	0.016727	0.010036	0.000760	0.000000	0.000000	0.000000
SSW	0.009580	0.003345	0.000000	0.000000	0.000000	0.000000
SW	0.008060	0.001977	0.000152	0.000000	0.000000	0.000000
WSW	0.007603	0.002281	0.000152	0.000000	0.000000	0.000000
W	0.006691	0.003193	0.001064	0.000000	0.000000	0.000000
WNW	0.007603	0.002585	0.000000	0.000000	0.000000	0.000000
NW	0.007299	0.002433	0.000000	0.000000	0.000000	0.000000
NNW	0.006995	0.000760	0.000000	0.000000	0.000000	0.000000



STABILITY FREQUENCY PERCENTAGES

Ninepipe

Monitoring Site

STABILITY CLASS E

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.020073	0.004410	0.000304	0.000000	0.000000	0.000000
NNE	0.022506	0.004866	0.000000	0.000000	0.000000	0.000000
NE	0.021746	0.000608	0.000000	0.000000	0.000000	0.000000
ENE	0.014142	0.000152	0.000000	0.000000	0.000000	0.000000
E	0.015055	0.000456	0.000000	0.000000	0.000000	0.000000
ESE	0.020225	0.001217	0.000000	0.000000	0.000000	0.000000
SE	0.036192	0.004410	0.000000	0.000000	0.000000	0.000000
SSE	0.045316	0.017944	0.000000	0.000000	0.000000	0.000000
S	0.031022	0.028133	0.002737	0.000000	0.000000	0.000000
SSW	0.016423	0.006539	0.000152	0.000000	0.000000	0.000000
SW	0.011405	0.004106	0.000304	0.000000	0.000000	0.000000
WSW	0.010189	0.005931	0.000456	0.000152	0.000000	0.000000
W	0.010341	0.012470	0.000456	0.000000	0.000000	0.000000
WNW	0.009580	0.007451	0.000304	0.000000	0.000000	0.000000
NW	0.013078	0.002737	0.000000	0.000000	0.000000	0.000000
NNW	0.013534	0.001977	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.013534	0.003802	0.000456	0.000000	0.000000	0.000000
NNE	0.013382	0.001521	0.000000	0.000000	0.000000	0.000000
NE	0.016423	0.000152	0.000000	0.000000	0.000000	0.000000
ENE	0.011101	0.000152	0.000000	0.000000	0.000000	0.000000
E	0.012926	0.000152	0.000000	0.000000	0.000000	0.000000
ESE	0.010797	0.000152	0.000000	0.000000	0.000000	0.000000
SE	0.021746	0.000608	0.000000	0.000000	0.000000	0.000000
SSE	0.021746	0.001673	0.000000	0.000000	0.000000	0.000000
S	0.012926	0.002585	0.000000	0.000000	0.000000	0.000000
SSW	0.008668	0.000304	0.000000	0.000000	0.000000	0.000000
SW	0.003954	0.000304	0.000000	0.000000	0.000000	0.000000
WSW	0.004410	0.000608	0.000000	0.000000	0.000000	0.000000
W	0.004410	0.002433	0.000000	0.000000	0.000000	0.000000
WNW	0.004562	0.001977	0.000000	0.000000	0.000000	0.000000
NW	0.006235	0.001064	0.000000	0.000000	0.000000	0.000000
NNW	0.010341	0.001217	0.000000	0.000000	0.000000	0.000000



TABLE 2.17
STABILITY FREQUENCY PERCENTAGES
Polson
Monitoring Site

STABILITY CLASS A

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.001691	0.000677	0.000000	0.000000	0.000000	0.000000
NNE	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000169	0.000169	0.000000	0.000000	0.000000	0.000000
SE	0.000846	0.000169	0.000000	0.000000	0.000000	0.000000
SSE	0.000507	0.000338	0.000000	0.000000	0.000000	0.000000
S	0.001184	0.000677	0.000000	0.000000	0.000000	0.000000
SSW	0.000677	0.000507	0.000000	0.000000	0.000000	0.000000
SW	0.000846	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000169	0.000338	0.000000	0.000000	0.000000	0.000000
W	0.000507	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000338	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000677	0.000169	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.004567	0.001015	0.000000	0.000000	0.000000	0.000000
NNE	0.001522	0.000169	0.000000	0.000000	0.000000	0.000000
NE	0.000846	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000846	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.001015	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.001015	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.001353	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.003045	0.002537	0.000000	0.000000	0.000000	0.000000
S	0.003552	0.003721	0.000169	0.000000	0.000000	0.000000
SSW	0.003214	0.002030	0.000000	0.000000	0.000000	0.000000
SW	0.001353	0.001353	0.000507	0.000000	0.000000	0.000000
WSW	0.001184	0.000677	0.000000	0.000000	0.000000	0.000000
W	0.001015	0.000507	0.000000	0.000000	0.000000	0.000000
WNW	0.000169	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.001522	0.000169	0.000000	0.000000	0.000000	0.000000
NNW	0.004905	0.001522	0.000169	0.000000	0.000000	0.000000



TABLE 2.17 (cont.)
STABILITY FREQUENCY PERCENTAGES
Polson
Monitoring Site

STABILITY CLASS C

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.004736	0.003552	0.000000	0.000000	0.000000	0.000000
NNE	0.002537	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.001691	0.000169	0.000000	0.000000	0.000000	0.000000
ENE	0.001522	0.000338	0.000000	0.000000	0.000000	0.000000
E	0.001861	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.001184	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.004567	0.001691	0.000000	0.000000	0.000000	0.000000
SSE	0.007950	0.015392	0.000507	0.000000	0.000000	0.000000
S	0.008796	0.011164	0.000000	0.000000	0.000000	0.000000
SSW	0.003045	0.005582	0.000000	0.000000	0.000000	0.000000
SW	0.002537	0.001861	0.000000	0.000000	0.000000	0.000000
WSW	0.002199	0.000338	0.000000	0.000000	0.000000	0.000000
W	0.003045	0.000507	0.000000	0.000000	0.000000	0.000000
WNW	0.001522	0.000169	0.000000	0.000000	0.000000	0.000000
NW	0.002030	0.000169	0.000000	0.000000	0.000000	0.000000
NNW	0.012855	0.005582	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS D

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.009811	0.004398	0.000000	0.000000	0.000000	0.000000
NNE	0.006597	0.001015	0.000000	0.000000	0.000000	0.000000
NE	0.004060	0.000338	0.000000	0.000000	0.000000	0.000000
ENE	0.003383	0.000338	0.000000	0.000000	0.000000	0.000000
E	0.004229	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.006935	0.000507	0.000000	0.000000	0.000000	0.000000
SE	0.010487	0.005920	0.000000	0.000000	0.000000	0.000000
SSE	0.015900	0.033999	0.000169	0.000000	0.000000	0.000000
S	0.015223	0.025541	0.001015	0.000000	0.000000	0.000000
SSW	0.009641	0.010149	0.000169	0.000000	0.000000	0.000000
SW	0.007612	0.004736	0.000169	0.000000	0.000000	0.000000
WSW	0.004567	0.002199	0.000000	0.000000	0.000000	0.000000
W	0.003552	0.001522	0.001015	0.000000	0.000000	0.000000
WNW	0.002537	0.000677	0.000000	0.000000	0.000000	0.000000
NW	0.004736	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.010149	0.008457	0.000169	0.000000	0.000000	0.000000



TABLE 2.17 (cont.)
STABILITY FREQUENCY PERCENTAGES
Polson
Monitoring Site

STABILITY CLASS E

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.020467	0.006766	0.000338	0.000000	0.000000	0.000000
NNE	0.008796	0.004229	0.000000	0.000000	0.000000	0.000000
NE	0.009134	0.001353	0.000000	0.000000	0.000000	0.000000
ENE	0.007104	0.000507	0.000000	0.000000	0.000000	0.000000
E	0.008457	0.000507	0.000000	0.000000	0.000000	0.000000
ESE	0.007273	0.000677	0.000000	0.000000	0.000000	0.000000
SE	0.016407	0.006258	0.000000	0.000000	0.000000	0.000000
SSE	0.029263	0.051421	0.000000	0.000000	0.000000	0.000000
S	0.035014	0.060047	0.002537	0.000000	0.000000	0.000000
SSW	0.021820	0.017930	0.000000	0.000000	0.000000	0.000000
SW	0.010149	0.011502	0.000338	0.000000	0.000000	0.000000
WSW	0.008627	0.003552	0.000000	0.000000	0.000000	0.000000
W	0.006258	0.004398	0.000169	0.000000	0.000000	0.000000
WNW	0.004736	0.001184	0.000169	0.000000	0.000000	0.000000
NW	0.009134	0.000507	0.000000	0.000000	0.000000	0.000000
NNW	0.014885	0.010656	0.000338	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.018099	0.002030	0.000000	0.000000	0.000000	0.000000
NNE	0.006258	0.000507	0.000000	0.000000	0.000000	0.000000
NE	0.006935	0.000677	0.000000	0.000000	0.000000	0.000000
ENE	0.006428	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.009134	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.009472	0.000846	0.000000	0.000000	0.000000	0.000000
SE	0.016238	0.002199	0.000000	0.000000	0.000000	0.000000
SSE	0.019452	0.011502	0.000000	0.000000	0.000000	0.000000
S	0.019621	0.008796	0.000507	0.000000	0.000000	0.000000
SSW	0.005751	0.003721	0.000677	0.000000	0.000000	0.000000
SW	0.004736	0.002199	0.000169	0.000000	0.000000	0.000000
WSW	0.003890	0.000846	0.000000	0.000000	0.000000	0.000000
W	0.005244	0.001015	0.000000	0.000000	0.000000	0.000000
WNW	0.003214	0.000677	0.000000	0.000000	0.000000	0.000000
NW	0.010995	0.000677	0.000000	0.000000	0.000000	0.000000
NNW	0.020805	0.005413	0.000169	0.000000	0.000000	0.000000



TABLE 2.18

STABILITY FREQUENCY PERCENTAGES

Bigfork

Monitoring Site

STABILITY CLASS A

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
S	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

STABILITY CLASS B

WINDSPEED CATEGORIES IN M/SEC

	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.000730	0.000000	0.000000	0.000000	0.000000	0.000000
NNE	0.001168	0.000438	0.000000	0.000000	0.000000	0.000000
NE	0.001606	0.000146	0.000000	0.000000	0.000000	0.000000
ENE	0.001168	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.000730	0.000000	0.000000	0.000000	0.000000	0.000000
ESE	0.000730	0.000000	0.000000	0.000000	0.000000	0.000000
SE	0.000292	0.000000	0.000000	0.000000	0.000000	0.000000
SSE	0.000584	0.000146	0.000000	0.000000	0.000000	0.000000
S	0.000584	0.000000	0.000000	0.000000	0.000000	0.000000
SSW	0.000584	0.000292	0.000000	0.000000	0.000000	0.000000
SW	0.002482	0.000438	0.000000	0.000000	0.000000	0.000000
WSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
W	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WNW	0.001022	0.000000	0.000000	0.000000	0.000000	0.000000
NW	0.000438	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.001022	0.000146	0.000000	0.000000	0.000000	0.000000



TABLE 2.18 (cont.)
STABILITY FREQUENCY PERCENTAGES
Bigfork
Monitoring Site

STABILITY CLASS C

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.004381	0.001460	0.000000	0.000000	0.000000	0.000000
NNE	0.007155	0.001752	0.000292	0.000000	0.000000	0.000000
NE	0.009930	0.000730	0.000000	0.000000	0.000000	0.000000
ENE	0.005549	0.001168	0.000146	0.000000	0.000000	0.000000
E	0.005695	0.002190	0.000000	0.000000	0.000000	0.000000
ESE	0.004089	0.000876	0.000000	0.000000	0.000000	0.000000
SE	0.003505	0.001168	0.000146	0.000000	0.000000	0.000000
SSE	0.003651	0.002921	0.000584	0.000000	0.000000	0.000000
S	0.004965	0.003359	0.000292	0.000000	0.000000	0.000000
SSW	0.008178	0.005549	0.000146	0.000000	0.000000	0.000000
SW	0.009054	0.000438	0.000000	0.000000	0.000000	0.000000
WSW	0.004235	0.000292	0.000000	0.000000	0.000000	0.000000
W	0.004235	0.000146	0.000000	0.000000	0.000000	0.000000
WNW	0.004527	0.000730	0.000000	0.000000	0.000000	0.000000
NW	0.005549	0.000730	0.000292	0.000000	0.000000	0.000000
NNW	0.003943	0.000730	0.000292	0.000000	0.000000	0.000000

STABILITY CLASS D

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.010514	0.002775	0.000146	0.000000	0.000000	0.000000
NNE	0.013143	0.002336	0.000292	0.000000	0.000000	0.000000
NE	0.012412	0.000876	0.000000	0.000000	0.000000	0.000000
ENE	0.010514	0.000730	0.000000	0.000000	0.000000	0.000000
E	0.009492	0.002044	0.000146	0.000000	0.000000	0.000000
ESE	0.005257	0.001168	0.000000	0.000000	0.000000	0.000000
SE	0.006717	0.001460	0.000292	0.000000	0.000000	0.000000
SSE	0.007009	0.002336	0.000292	0.000000	0.000000	0.000000
S	0.009638	0.008762	0.000146	0.000000	0.000000	0.000000
SSW	0.010806	0.009492	0.000000	0.000000	0.000000	0.000000
SW	0.009200	0.002336	0.000000	0.000000	0.000000	0.000000
WSW	0.005841	0.001898	0.000000	0.000000	0.000000	0.000000
W	0.003943	0.001168	0.000000	0.000000	0.000000	0.000000
WNW	0.004819	0.000876	0.000000	0.000000	0.000000	0.000000
NW	0.007886	0.001022	0.000292	0.000000	0.000000	0.000000
NNW	0.008762	0.000876	0.000438	0.000000	0.000000	0.000000



TABLE 2.18 (cont.)
STABILITY FREQUENCY PERCENTAGES
Bigfork
Monitoring Site

STABILITY CLASS E

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.045853	0.004527	0.000292	0.000000	0.000000	0.000000
NNE	0.075643	0.004381	0.000146	0.000000	0.000000	0.000000
NE	0.049504	0.001752	0.000730	0.000292	0.000000	0.000000
ENE	0.024241	0.001752	0.000000	0.000000	0.000000	0.000000
E	0.028621	0.003943	0.000000	0.000000	0.000000	0.000000
ESE	0.014895	0.001898	0.000000	0.000000	0.000000	0.000000
SE	0.015479	0.002921	0.000584	0.000000	0.000000	0.000000
SSE	0.015041	0.005841	0.000876	0.000000	0.000000	0.000000
S	0.042202	0.017815	0.000000	0.000000	0.000000	0.000000
SSW	0.037237	0.022196	0.000000	0.000000	0.000000	0.000000
SW	0.027307	0.004089	0.000000	0.000000	0.000000	0.000000
WSW	0.011974	0.001314	0.000000	0.000000	0.000000	0.000000
W	0.009638	0.002482	0.000000	0.000000	0.000000	0.000000
WNW	0.010368	0.000292	0.000000	0.000000	0.000000	0.000000
NW	0.014165	0.001314	0.000146	0.000000	0.000000	0.000000
NNW	0.020152	0.001752	0.001022	0.000000	0.000000	0.000000

STABILITY CLASS F OR G

	WINDSPEED CATEGORIES IN M/SEC					
	0.0 to 1.34	1.35 to 3.55	3.56 to 5.38	5.39 to 8.47	8.48 to 10.74	>10.74
N	0.012266	0.002921	0.000146	0.000000	0.000000	0.000000
NNE	0.017523	0.001752	0.000000	0.000000	0.000000	0.000000
NE	0.012412	0.000292	0.000292	0.000146	0.000000	0.000000
ENE	0.009346	0.000584	0.000000	0.000000	0.000000	0.000000
E	0.007447	0.001022	0.000000	0.000146	0.000000	0.000000
ESE	0.006133	0.000584	0.000000	0.000000	0.000000	0.000000
SE	0.003797	0.000730	0.000000	0.000000	0.000000	0.000000
SSE	0.003943	0.002629	0.000292	0.000000	0.000000	0.000000
S	0.009054	0.003943	0.000000	0.000000	0.000000	0.000000
SSW	0.013581	0.001606	0.000000	0.000000	0.000000	0.000000
SW	0.014895	0.001314	0.000000	0.000000	0.000000	0.000000
WSW	0.008032	0.000146	0.000000	0.000000	0.000000	0.000000
W	0.004965	0.000146	0.000292	0.000000	0.000000	0.000000
WNW	0.006717	0.000146	0.000000	0.000000	0.000000	0.000000
NW	0.009638	0.000876	0.000146	0.000000	0.000000	0.000000
NNW	0.005841	0.001314	0.000292	0.000000	0.000000	0.000000



3.0 AIRSHEDS

Following the meteorological data review, Bison determined that reliable data was available for six monitoring sites sufficient to allow diffusion modeling analysis. The general topography, meteorological data, and available air pollution emission data were reviewed to determine the area (airshed) best described by the data available. The airshed boundaries and size varied greatly from site to site especially due to terrain. The final airshed designations were determined after consultation with the Air Quality Bureau. Figure 3.1 shows the entire Basin and the location of the monitoring sites. Figures 3.2 through 3.7 show the various airsheds selected and the two kilometer grids for model analysis, the monitor locations, and the point sources of air pollution in the various airsheds.



FLATHEAD RIVER BASIN ENVIRONMENTAL IMPACT STUDY STUDY AREA MAP

MONITOR SITES:

- 1) MOOSE CITY
- 2) POLEBRIDGE
- 3) COL. FALLS - NAAC
- 4) COL. FALLS - ANDERS
- 5) KALISPELL - AIRPORT
- 6) KALISPELL - STROM
- 7) KALISPELL - UNIV. ATH.
- 8) KALISPELL - EVERGREEN
- 9) BIG FORK
- 10) POLSON
- 11) RONAN
- 12) NINE PIPE
- 13) WHITEFISH
- 14) SWAN YOUTH CAMP
- 15) RONAN (TRIBAL)
- 16) ST. IGNATIUS (TRIBAL)
- 17) ARLEE
- 18) EVARO

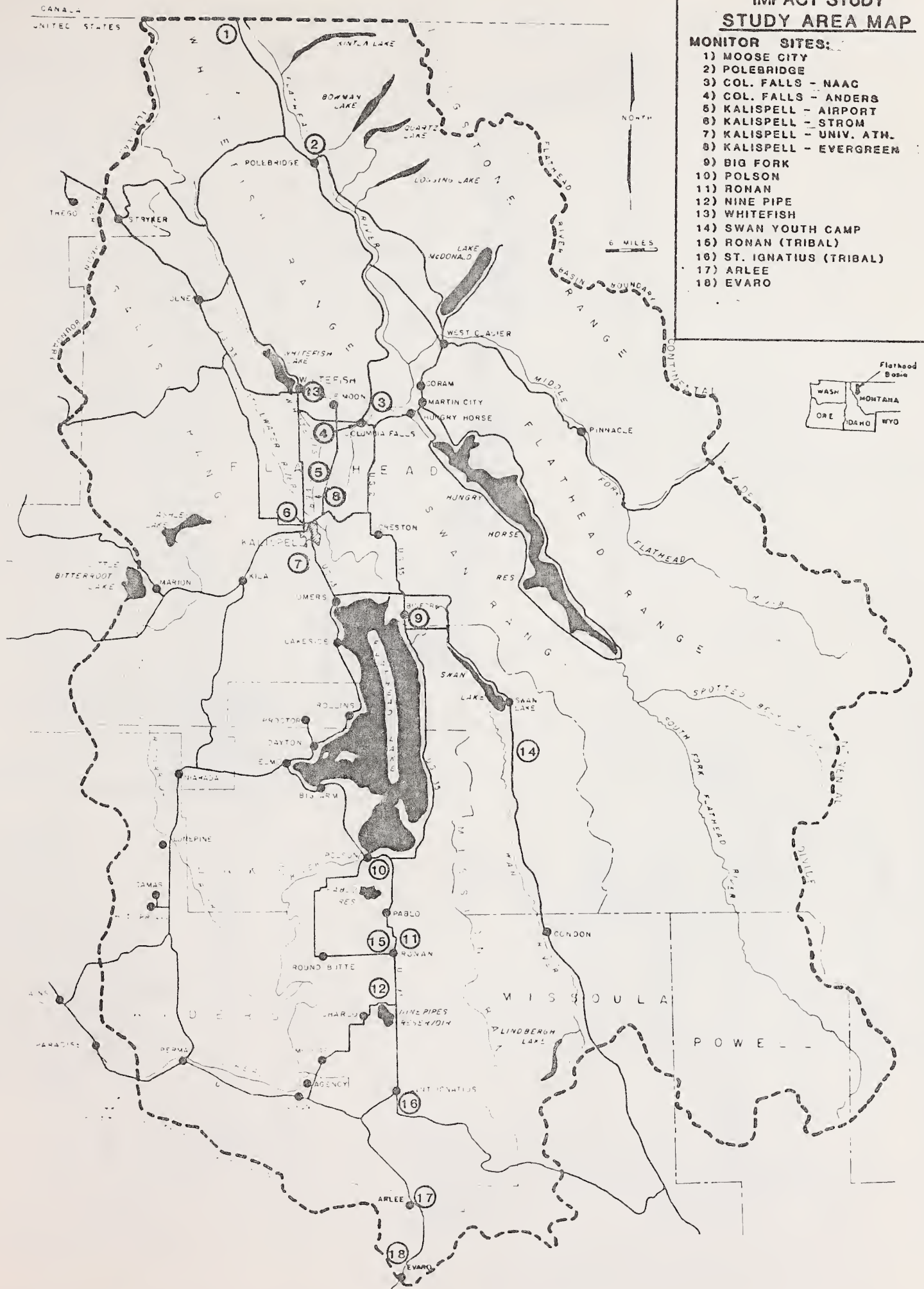


Figure 3.1

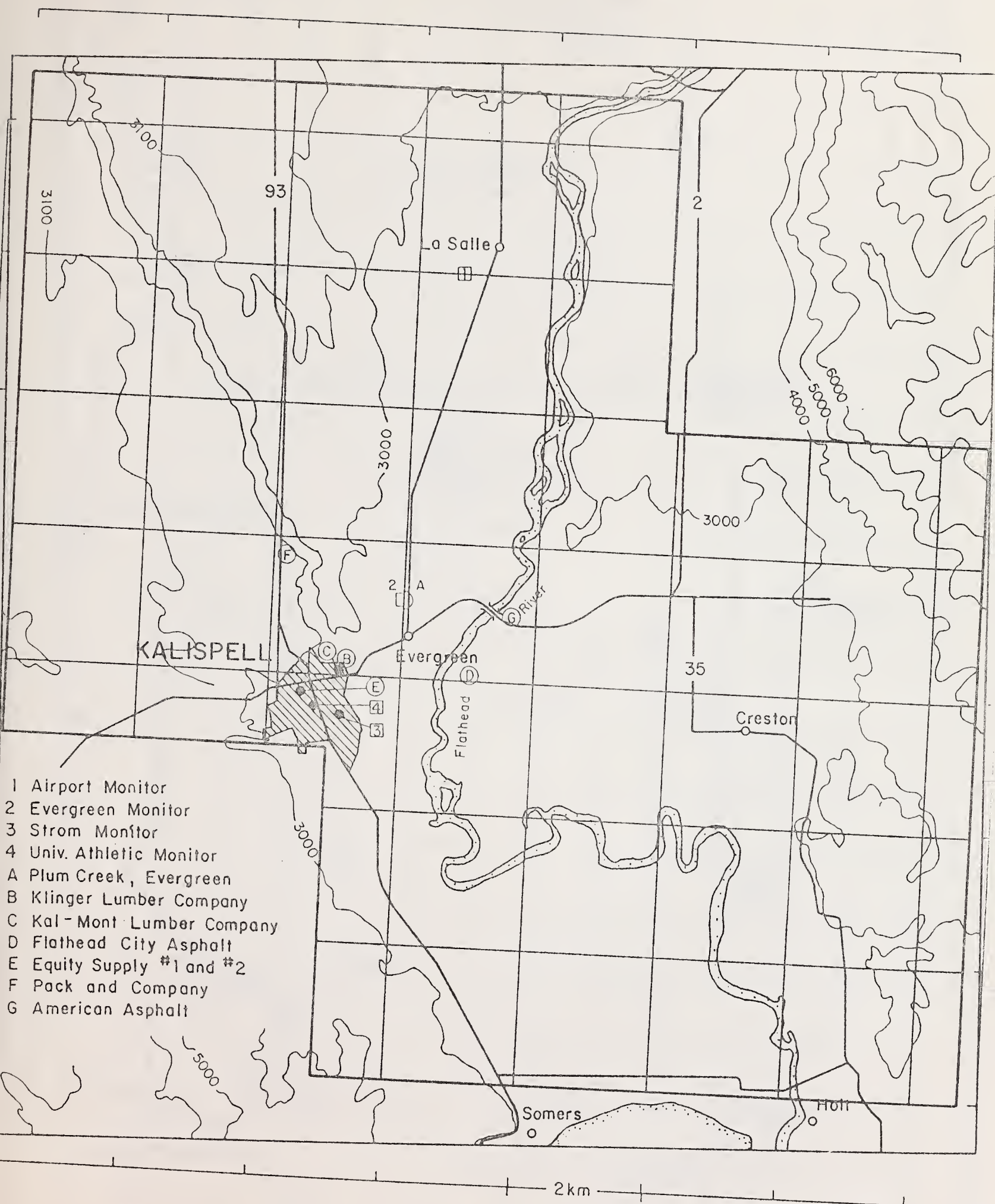


FIGURE 3.2 Kalispell Airshed

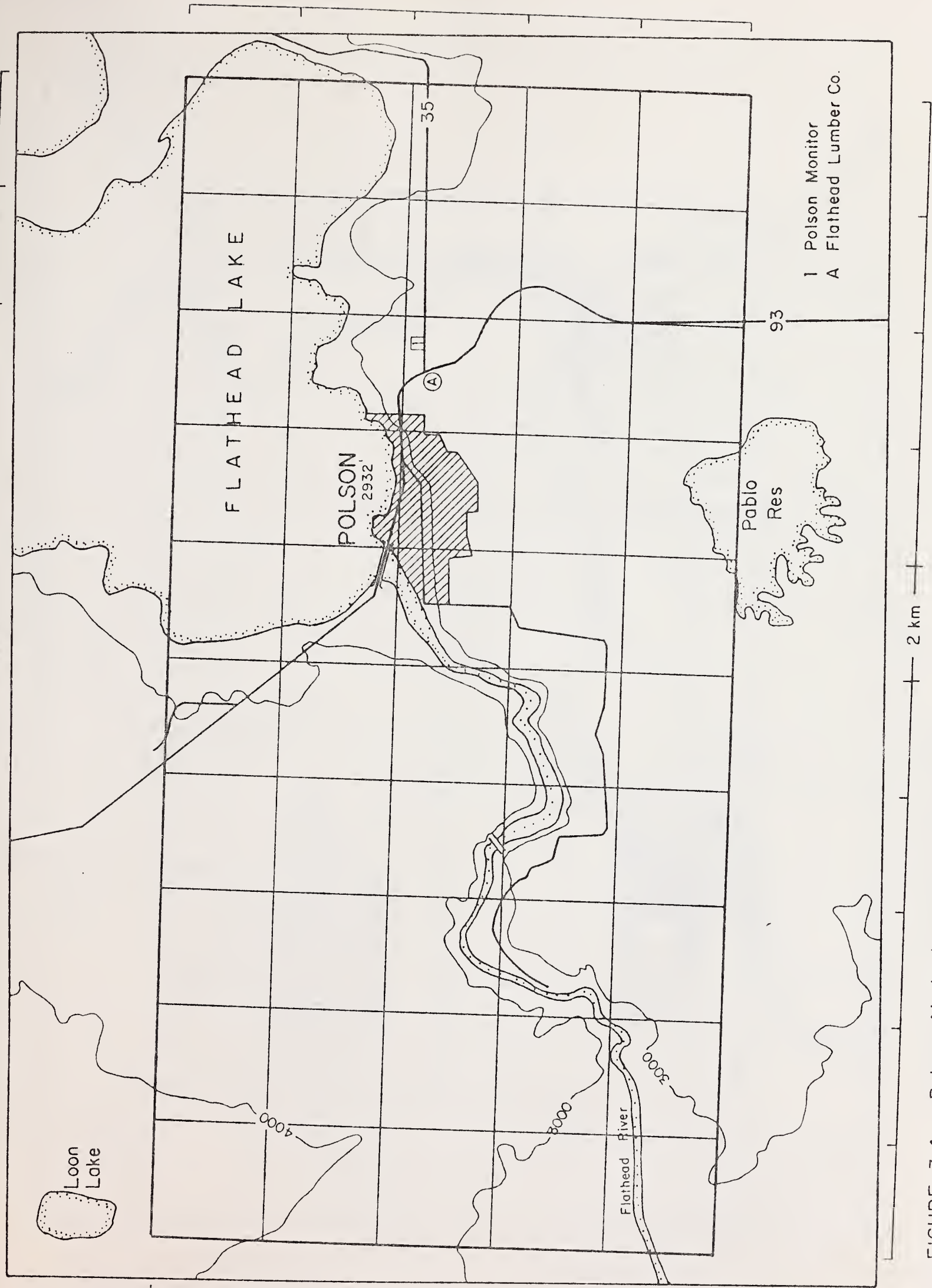


FIGURE 3.4 Polson Airshed

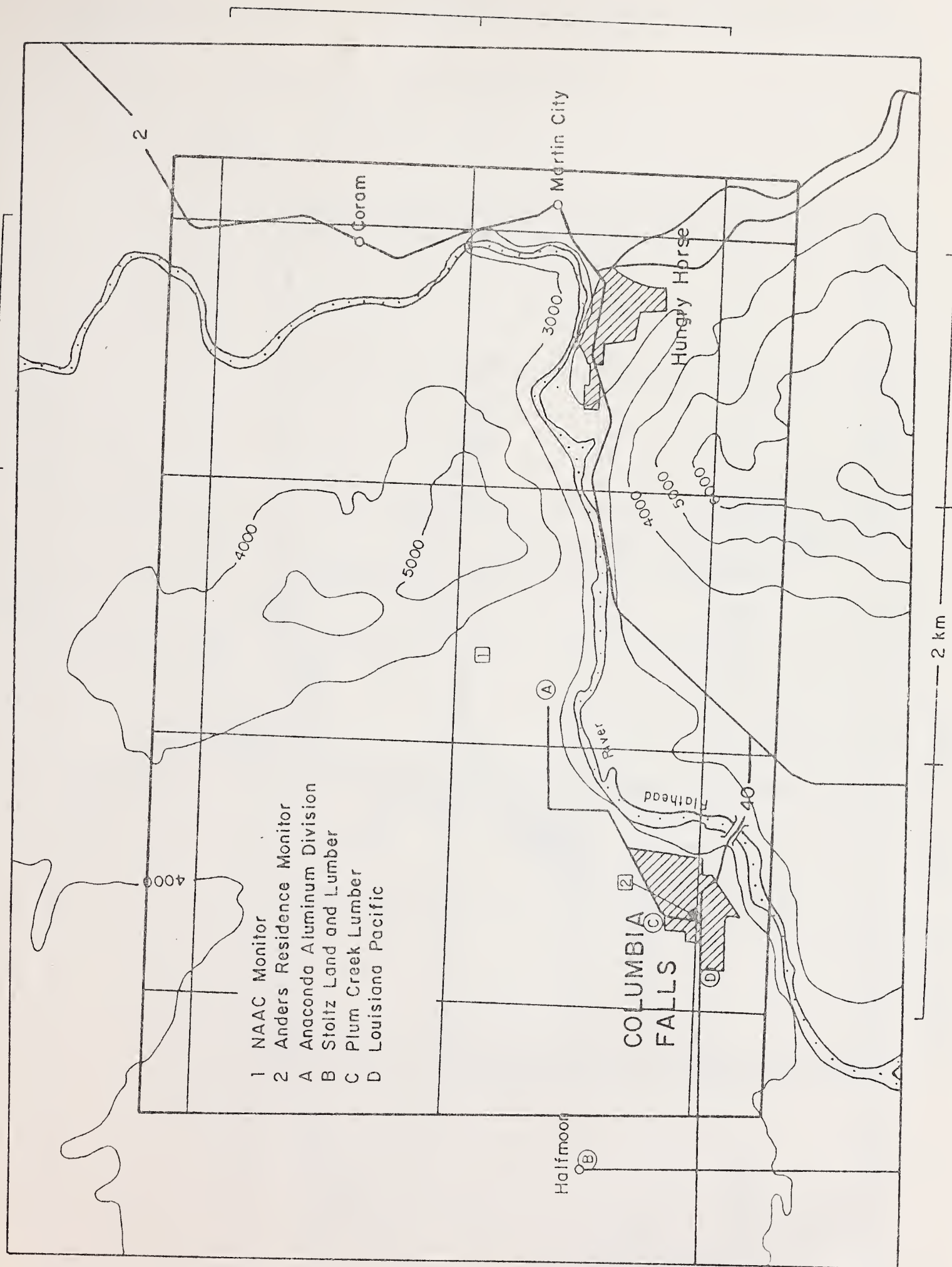


FIGURE 3.5 Columbia Falls Airshed

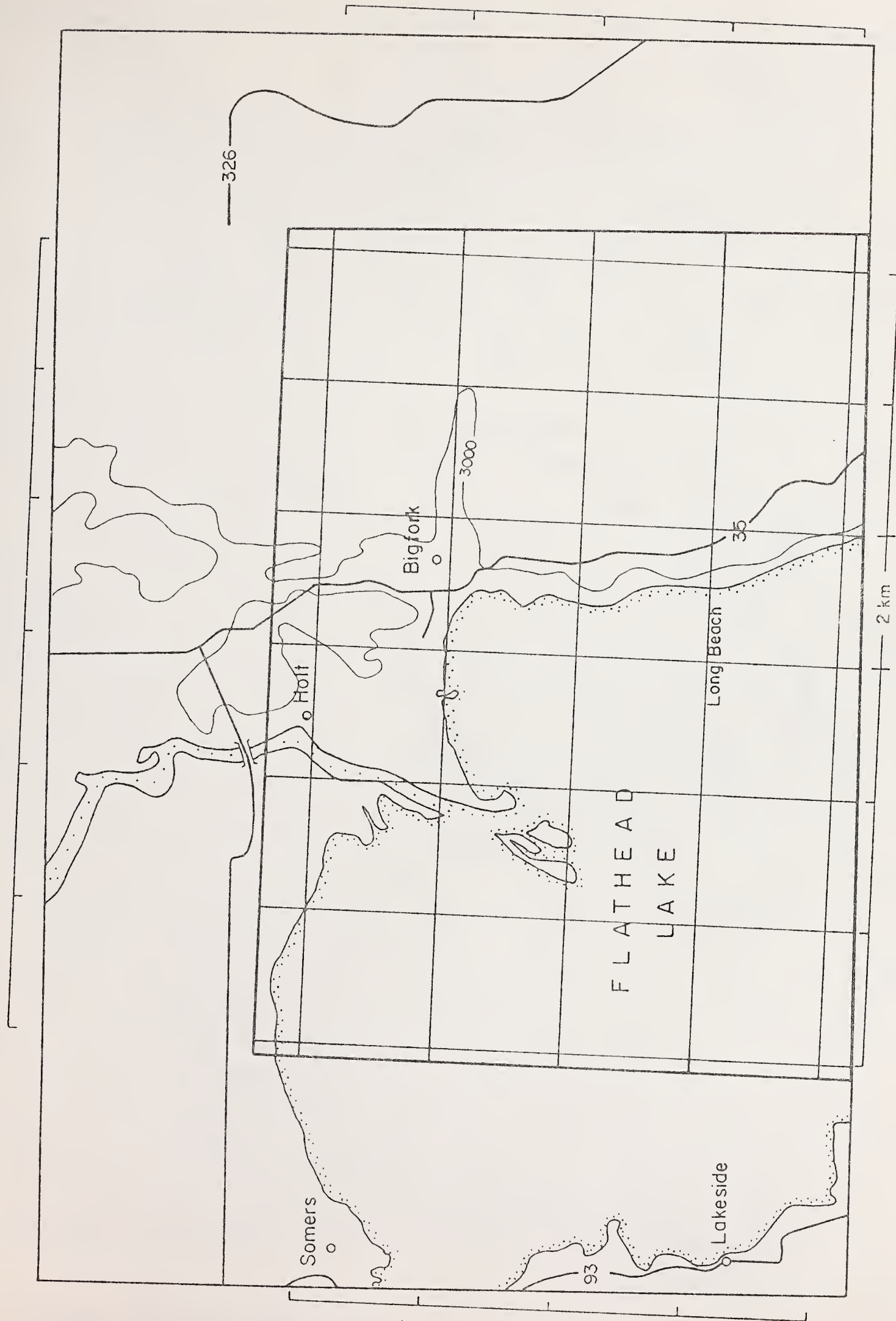


FIGURE 3.6 Bigfork Airshed

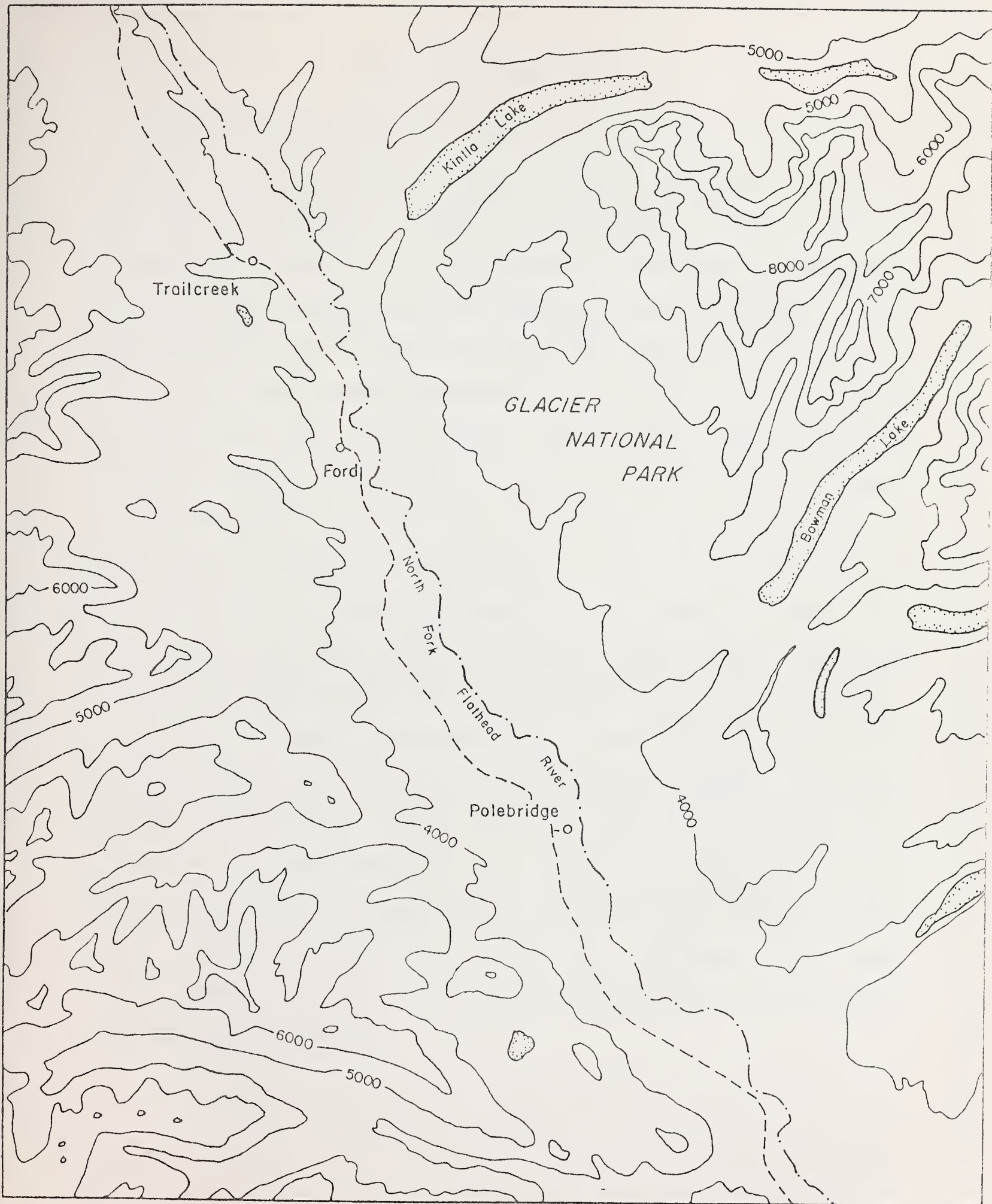


FIGURE 3.7 North Fork Airshed

4.0 EMISSION DATA

The Air Quality Bureau supplied Bison with a copy of the Flathead River Basin Area Source Emission Inventory (Stewart, 1980) and a computer listing of the point source emission inventory of Missoula and Lake Counties. The data listings were reviewed for completeness and updated where necessary. The appendix shows the various point sources with the seasonal and hourly variations, stack parameters, and emission rates. Primary reference for the point source data was the AQB emission inventory listing. Modifications were made where necessary based on recommendations of AQB. The fugitive dust emissions from the point source inventory were given a fixed plume height of 10 meters and then no plume rise beyond the 10 meters allowed. The fixed plume height was set as the fugitive dust sources generally had undefined exit velocities, stack diameters or stack heights.

The area source emissions were taken directly from the Flathead River Basin Area Source Emission Inventory. The only changes made were to attach seasonal scalars to weight the emissions of such sources as paved and unpaved roads, agricultural tilling, slash burning, and wood fuel usage to match emission rates to the seasons of the year. Listings of the area source emission rates by zone and by major source category are included in the appendix.



5.0 MODEL SELECTION

5.1 Short-term Models

Bison performed a review of the various parameters of the Basin and the available diffusion models. Based on the Environmental Protection Agency Guidelines on Air Quality Models document and discussions with the AQB, one short-term and one long-term diffusion model were selected for each airshed. An attempt was made to select only EPA recommended models for "refined" analyses. Only for the North Fork of the Flathead River were screening models selected. The primary variables affecting the selection of the models were:

Pollutant: Particulates

Time Period: Annual, 24-Hour

Source Types: Area, Point (Multiple)

Urban, Rural Mode: Urban

Terrain: Small variations except
the North Fork Airshed

The Guideline document lists the Industrial Source Complex (ISC) model as the only applicable refined model for the various criteria listed. The ISC model is actually two models -- ISCLT (long-term) and ISCST (short-term). For the North Fork of the Flathead River, terrain complexities made the model selection very limited. The recommended "screening" model is the VALLEY model. The VALLEY model was selected for the annual period simulation. For the short-term (24-hour) analysis, a multiple box model designed by Bison was selected for the North Fork airshed.



The box model allows up to nine boxes of varying size and orientation to be simulated. Hourly meteorological data are input for up to 120 hours. Concentrations of air pollutants are listed for each hour and box simulated.

ISCLT model (long-term) is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial source complex. The model can account for settling and dry deposition of particulates; downwash; area, line, and volume sources; plume rise as a function of downwind distance; separation of point sources; and limited terrain adjustment.

ISCST model (short-term) is similar to ISCLT but calculates concentrations of pollutants for 1-, 2-, 3-, 4-, 6-, 8-, 12- and/or 24- hour time periods.

The VALLEY model is a steady-state Gaussian plume model designed for estimating either 24-hour or annual concentrations resulting from emissions from up to 50 point and area sources. Calculations of ground-level pollutant concentrations are made for each frequency designated in an array of stability and wind occurrences (STAR deck listed in Section 2) and 112 receptor sites on 16 radials. Plume height is adjusted according to terrain elevations and stability classes.



6.0 RESULTS

6.1 North Fork Airshed

Bison utilized two models on the North Fork of the Flathead River. The first model was the Bison multiple box model for short term particulate concentrations. The second model used was the EPA VALLEY model. For the box model analysis the upper North Fork area was divided into six boxes, each five kilometers long starting with the first box at the U.S.-Canada border. The box widths varied with the valley widths. Analyses were performed on the six boxes using three methods. They were: (1) varying each individual box width; (2) varying the natural particulate removal rate; and (3) using different time periods.

The box widths were varied by specifying three height differences between the valley floor and the maximum top of a box wall. The heights used were 1600, 800 and 200 feet. The resulting box widths are listed in Table 6.1 along with the emission rates of the particulates. Emission rates used were for the present area sources in the valley. New sources such as the Cabin Creek Mine were simulated in later model executions.

The particulate removal rates varied from 0 percent to 20 percent per hour. The total mass of particulates in each box at the end of the hour was reduced by the rate simulated for that model run.

The time periods simulated were 5-day or 120-hour periods during three times of the 1979 and 1980 periods. The dates selected were the same periods previously used by the Air Quality



Bureau in an analysis of the Cabin Creek Mine. The dates included periods of near stagnation conditions with a northerly wind flow. The dates simulated are shown in Table 6.2. Table 6.2 also lists the mixing heights used in the model runs.

The results of the model runs are summarized in Tables 6.3 through 6.8. The individual hourly concentrations are listed in the appendix. The maximum predicted particulate value was 16.4 micrograms per cubic meter. This occurred with a 200 meter box height and no particulate removal.

For the long-term model simulation of the North Fork Airshed, the VALLEY model was run on the area sources of the region. The model utilized the terrain of the airshed in a 24 kilometer diameter circle centered 12 kilometers south of the U.S.-Canada border. The model utilized the STAR deck constructed from the Big Prairie wind data and the Glacier International Airport stability data. The model results are presented in the appendix along with the listing of the model inputs. The maximum concentration predicted for the annual period of the North Fork airshed was 17.6 micrograms per cubic meter (ug/m^3). Concentrations varied from a low of 3.2 ug/m^3 near the west edge of the airshed to 17.6 ug/m^3 at the east edge. The maximum annual value did exceed the maximum 24-hour value predicted by the box model. This difference is mainly due to the location of the concentrations. The box model predicts only for the valley whereas the VALLEY model maximum occurred in the elevated terrain in Glacier National Park.



TABLE 6.1

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL INPUT DATA

H = 1600 Ft*

BOX	LENGTH (km)	WIDTH (km)	EMISSION RATE (g/sec)
1 (north)	5	10	3.2
2	5	12	2.1
3	5	11	1.0
4	5	13	1.2
5	5	9	3.5
6 (south)	5	11	4.2

H = 800 Ft*

BOX	LENGTH (km)	WIDTH (km)	EMISSION RATE (g/sec)
1 (north)	5	6	3.2
2	5	7	2.1
3	5	8	1.0
4	5	10	1.2
5	5	6.5	3.5
6 (south)	5	6.5	4.2

H = 200 Ft*

BOX	LENGTH (km)	WIDTH (km)	EMISSION RATE (g/sec)
1 (north)	5	4	3.2
2	5	5	2.1
3	5	4	1.0
4	5	6	1.2
5	5	4	3.5
6 (south)	5	3	4.2

*H = Elevation difference between the valley floor and the top of the boxes; used for width dimensions only.



TABLE 6.2

NORTH FORK FLATHEAD RIVER AIRSHED
 MULTIPLE BOX MODEL METEOROLOGICAL DATA

WIND DATA

<u>RUN</u>	<u>SOURCE</u>	<u>DATES</u>
1	Polebridge	November 8-12, 1979
2	Polebridge	November 13-18, 1979
3	Polebridge	August 6-10, 1980

MIXING HEIGHT DATA

<u>HOURL</u>	<u>HEIGHT (m)</u>	<u>HOURL</u>	<u>HEIGHT (m)</u>
1	100	13	1000
2	100	14	1000
3	100	15	1000
4	100	16	300
5	100	17	300
6	100	18	300
7	100	19	300
8	100	20	300
9	100	21	300
10	300	22	100
11	300	23	100
12	300	24	100



TABLE 6.3

NORTH FORK FLATHEAD RIVER AIRSHED
MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 200 L = 0%

DATE	Box					
	1	2	3	4	5	6
Nov. 8, 1979	1.0	2.2	0.7	0.6	1.5	1.5
Nov. 9, 1979	0.1	2.0	0.3	0.2	0.3	0
Nov. 10, 1979	0.2	2.2	0.1	0	0.2	0.4
Nov. 11, 1979	0.1	2.3	0.4	0.5	0	0
Nov. 12, 1979	0.2	4.0	1.8	2.1	3.5	0.1
Ave. Nov. 8-12, 1979	0.3	2.5	0.7	0.7	1.1	0.4
Nov. 13, 1979	2.5	5.0	0.8	0.5	2.7	4.3
Nov. 14, 1979	5.9	7.5	1.9	1.5	6.5	10.2
Nov. 15, 1979	8.8	6.9	2.9	2.2	9.6	15.0
Nov. 16, 1979	9.3	7.8	4.1	2.5	10.2	15.2
Nov. 17, 1979	5.6	5.2	2.8	2.6	7.6	9.3
Ave. Nov. 13-17, 1979	6.4	6.5	2.5	1.9	7.3	10.8
Aug. 6, 1980	5.6	4.6	2.2	1.9	6.7	9.5
Aug. 7, 1980	7.3	7.9	2.6	2.0	8.1	12.5
Aug. 8, 1980	9.5	7.3	3.0	2.4	10.3	16.4
Aug. 9, 1980	2.5	2.9	1.2	0.8	3.0	4.0
Aug. 10, 1980	9.7	8.6	4.5	3.0	11.1	15.8
Ave. Aug. 6-10, 1980	6.9	6.3	2.7	2.0	7.8	11.6

*L = Percentage of natural removal of air pollutants.



TABLE 6.4

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 800 L = 0%

Box

DATE	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Nov. 8, 1979	0.7	1.5	0.3	0.4	0.9	0.7
Nov. 9, 1979	0	1.5	0.2	0.1	0.2	0
Nov. 10, 1979	0.2	1.7	0	0	0.2	0.2
Nov. 11, 1979	0.1	1.8	0.2	0.3	0.3	0
Nov. 12, 1979	0.1	3.0	0.8	1.2	2.1	0
Ave. Nov. 8-12, 1979	0.2	1.9	0.3	0.4	0.7	0.2
Nov. 13, 1979	1.7	3.6	0.4	0.4	1.7	2.0
Nov. 14, 1979	3.9	5.3	0.9	0.9	3.9	4.7
Nov. 15, 1979	5.9	4.0	1.4	1.3	5.9	7.0
Nov. 16, 1979	6.2	5.6	2.0	1.5	6.2	7.0
Nov. 17, 1979	3.7	3.5	1.3	1.6	4.6	4.3
Ave. Nov. 13-17, 1979	4.3	4.4	3.5	1.1	4.5	5.0
Aug. 6, 1980	3.7	3.2	1.0	1.2	4.1	4.4
Aug. 7, 1980	4.9	5.4	1.3	1.2	5.0	5.8
Aug. 8, 1980	6.3	5.2	1.5	1.4	6.4	7.6
Aug. 9, 1980	1.6	2.2	0.6	0.4	1.8	1.9
Aug. 10, 1980	6.5	6.2	2.2	1.8	6.8	7.2
Ave. Aug. 6-10, 1980	4.6	4.4	1.3	1.9	4.8	5.4

*L = Percentage of natural removal of air pollutants.



TABLE 6.5

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 1600 L = 0%*

DATE	Box					
	1	2	3	4	5	6
Nov. 8, 1979	0.4	1.1	0.2	0.3	0.8	0.4
Nov. 9, 1979	0	1.0	0.1	0.1	0.2	0
Nov. 10, 1979	0.1	1.2	0	0	0.1	0.1
Nov. 11, 1979	0	1.2	0.1	0.2	0.3	0
Nov. 12, 1979	0.1	1.9	0.6	0.9	1.5	0
Ave. Nov. 8-12, 1979	0.1	1.3	0.2	0.3	0.6	0.1
Nov. 13, 1979	1.0	2.2	0.2	0.3	1.2	1.2
Nov. 14, 1979	2.2	3.2	0.7	0.7	2.9	2.8
Nov. 15, 1979	3.5	2.4	1.0	1.0	4.4	4.9
Nov. 16, 1979	3.7	3.3	1.5	1.1	4.5	4.1
Nov. 17, 1979	2.2	2.1	0.9	1.2	3.4	2.6
Ave. Nov. 13-17, 1979	2.5	2.6	0.9	0.9	3.3	3.1
Aug. 6, 1980	2.2	1.9	0.8	0.9	3.0	2.6
Aug. 7, 1980	3.0	3.2	0.9	0.9	3.6	3.4
Aug. 8, 1980	3.8	3.1	1.1	1.1	4.6	4.5
Aug. 9, 1980	1.0	1.2	0.3	0.3	1.3	1.1
Aug. 10, 1980	3.9	3.5	1.7	1.4	4.9	4.2
Ave. Aug. 6-10, 1980	2.8	2.6	1.0	0.9	3.5	3.2

*L = Percentage of natural removal of air pollutants.



TABLE 6.6

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 200 L = 10%*

DATE	Box					
	1	2	3	4	5	6
Nov. 8, 1979	0.8	1.9	0.5	0.6	1.4	1.4
Nov. 9, 1979	0.1	1.5	0.3	0.3	0.4	0
Nov. 10, 1979	0.2	1.7	0.1	0	0.3	0.4
Nov. 11, 1979	0.1	1.8	0.3	0.5	0.5	0
Nov. 12, 1979	0.2	3.4	1.5	1.9	3.1	0.1
Ave. Nov. 8-12, 1979	0.3	2.1	0.5	0.7	1.1	0.4
Nov. 13, 1979	2.2	4.5	0.7	0.5	2.5	3.9
Nov. 14, 1979	5.3	6.6	1.8	1.3	5.9	9.1
Nov. 15, 1979	7.8	5.1	2.5	2.0	8.7	13.7
Nov. 16, 1979	8.3	7.0	3.6	2.3	9.2	13.8
Nov. 17, 1979	5.0	4.6	2.5	2.4	6.9	8.4
Ave. Nov. 13-17, 1979	5.7	5.6	2.2	1.7	6.6	9.8
Aug. 6, 1980	5.0	4.2	1.9	1.7	6.0	8.5
Aug. 7, 1980	6.5	7.0	2.3	1.8	7.3	11.2
Aug. 8, 1980	8.4	6.6	2.7	2.1	9.3	14.8
Aug. 9, 1980	2.3	2.7	1.0	0.7	2.6	3.6
Aug. 10, 1980	8.7	7.8	4.0	2.7	10.0	14.2
Ave. Aug. 6-10, 1980	6.2	5.7	2.4	1.8	7.0	10.5

*L = Percentage of natural removal of air pollutants.



TABLE 6.7

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 800 L = 10%*

DATE	Box					
	1	2	2	4	5	6
Nov. 8, 1979	0.6	1.4	0.3	0.4	0.8	0.6
Nov. 9, 1979	0	1.1	0.2	0.2	0	0
Nov. 10, 1979	0.1	1.2	0	0	0.1	0.2
Nov. 11, 1979	0.1	1.3	0.2	0.3	0.3	0
Nov. 12, 1979	0.1	2.4	0.8	1.9	0	0
Ave. Nov. 8-12, 1979	0.2	1.5	0.3	0.6	0.2	0.2
Nov. 13, 1979	1.4	3.3	0.3	0.3	1.4	1.8
Nov. 14, 1979	3.5	4.8	0.9	0.8	3.6	4.3
Nov. 15, 1979	5.2	3.6	1.3	1.2	5.3	6.3
Nov. 16, 1979	5.6	5.0	1.8	1.3	5.5	6.3
Nov. 17, 1979	3.3	3.3	1.2	1.4	4.1	3.9
Ave. Nov. 13-17, 1979	3.8	4.0	1.1	1.0	4.0	4.5
Aug. 6, 1980	3.3	2.9	1.0	1.0	3.6	3.9
Aug. 7, 1980	4.3	4.9	1.2	1.0	4.4	5.2
Aug. 8, 1980	5.6	4.7	1.3	1.3	5.7	6.8
Aug. 9, 1980	1.5	1.9	0.5	0.3	1.6	1.7
Aug. 10, 1980	5.8	5.5	2.0	1.5	6.0	6.5
Ave. Aug. 6-10, 1980	4.1	4.0	1.2	1.0	4.3	4.8

*L = Percentage of natural removal of air pollutants.



TABLE 6.8

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

$$H = 200 \text{ L} = 20\%^*$$

DATE	Box					
	1	2	3	4	5	6
Nov. 8, 1979	0.8	1.8	0.5	0.5	1.2	1.2
Nov. 9, 1979	0	1.5	0.2	0.2	0.3	0
Nov. 10, 1979	0.2	1.7	0	0	0.2	0.3
Nov. 11, 1979	0.1	1.8	0.3	0.4	0.5	0
Nov. 12, 1979	0.1	3.2	1.4	1.7	2.7	0.1
Ave. Nov. 8-12, 1979	0.2	2.0	0.5	0.6	1.0	0.3
Nov. 13, 1979	2.0	4.0	0.5	0.4	2.0	3.4
Nov. 14, 1979	4.7	6.0	1.5	1.2	5.1	8.1
Nov. 15, 1979	7.0	4.5	2.2	1.8	8.1	10.4
Nov. 16, 1979	5.5	5.3	2.7	1.5	5.9	8.8
Nov. 17, 1979	4.5	4.0	2.2	2.1	6.1	7.4
Ave. Nov. 13-17, 1979	4.7	4.8	1.8	1.4	5.4	7.6
Aug. 6, 1980	4.4	3.5	1.7	1.5	5.3	7.5
Aug. 7, 1980	5.8	6.3	2.0	1.6	6.4	10.0
Aug. 8, 1980	7.5	5.8	2.4	1.9	8.2	13.1
Aug. 9, 1980	2.0	2.3	0.9	0.6	2.3	3.2
Aug. 10, 1980	7.7	6.8	3.5	2.3	8.8	12.5
Ave. Aug. 6-10, 1980	5.5	4.9	2.1	1.6	6.2	9.3

*L = Percentage of natural removal of air pollutants.



Bison prepared a model of the Cabin Creek Mine in the North Fork Airshed. The Mine was modeled for both the short and long term periods and for both sulfur dioxide and particulate matter. The short-term model used was the multiple box model with seven boxes working south from the mine down the North Fork of the Flathead River. Three five-day periods (same periods as previously discussed) were simulated with the box model with concentrations calculated for each one hour period. The emission rates used are listed in Table 6.9.

TABLE 6.9

CABIN CREEK MINE

EMISSION RATES (G/SEC)

Sulfur Dioxide

21.46

Particulates

62.24

The meteorological data used in the box model was obtained from wind data at the Big Prairie monitoring site.

The long-term model used was the Valley Model. The model calculated concentrations at 112 receptor points in 16 radials extending from a center near Polebridge. Radials were extended far enough to include the U.S.-Canada border and various areas of Glacier National Park. The model used a STAR deck prepared from wind data at Big Prairie and stability data at Glacier International Park. The emission rates listed in Table 6.9 were used in the Valley Model.

Tables 6.11 through 6.14 list the various 24-hour concentrations of particulate and sulfur dioxide for the box model. The tables show results for varying pollutant removal



rate (L) and varying mixing height (H in meters). Table 6.15 summarizes Tables 6.11-6.14. Table 6.15 shows the average increase in concentration for the 15 days simulated and the maximum 24-hour concentration increase. Box 1, the box starting just south of the U.S.-Canada border was exposed to the highest concentrations as expected. The maximum particulate increase for a 24-hour period varied from 33 to 58 micrograms per cubic meter (ug/m^3) depending on the L or H. The removal rate (L) appeared to have less effect than the mixing height (H). Since the Box 1 contains a portion of Glacier, a Class I area, the maximum 24-hour particulate level is compared against the Class I particulate matter increment of $10 \text{ ug}/\text{m}^3$. The maximum 24-hour increase of sulfur dioxide was $17.5 \text{ ug}/\text{m}^3$ which is also above the Class I sulfur dioxide increment of $5 \text{ ug}/\text{m}^3$.

Table 6.17 summarizes the Valley Model annual concentration increases due to the Cabin Creek Mine. Also shown in Table 6.17 are the Class I and II increments available. The maximum annual sulfur dioxide level predicted exceeds the Class I increment but is far below the Class II increment. The maximum annual particulate level predicted exceeds both the Class I and II increments. The location for the maximum actually occurred west of the North Fork of the Flathead River in a Class II area.



TABLE 6.11
NORTH FORK FLATHEAD RIVER AIRSHED
MULTIPLE BOX MODEL SULFUR DIOXIDE CONCENTRATIONS

(Values in micrograms per cubic meter)

H₀ = 200 L = 0%*

DATE	Box						
	A ⁺	1	2	3	4	5	6
Nov. 8, 1979	6.7	5.5	0.0	0.0	0.0	0.0	0.0
Nov. 9, 1979	5.3	13.1	0.4	0.0	0.0	0.0	0.0
Nov. 10, 1979	5.6	2.3	0.0	0.0	0.0	0.0	0.0
Nov. 11, 1979	5.3	4.3	0.0	0.0	0.0	0.0	0.0
Nov. 12, 1979	5.5	9.6	0.6	0.0	0.0	0.0	0.0
Ave. Nov. 8-12, 1979	5.7	6.7	0.2	0.0	0.0	0.0	0.0
Nov. 13, 1979	18.6	11.5	0.0	0.0	0.0	0.0	0.0
Nov. 14, 1979	32.8	14.3	0.0	0.0	0.0	0.0	0.0
Nov. 15, 1979	42.2	3.0	0.0	0.0	0.0	0.0	0.0
Nov. 16, 1979	57.0	17.5	0.0	0.0	0.0	0.0	0.0
Nov. 17, 1979	24.9	4.9	0.0	0.0	0.0	0.0	0.0
Ave. Nov. 13-17, 1979	35.1	10.2	0.0	0.0	0.0	0.0	0.0
Aug. 6, 1980	24.9	3.4	0.2	0.0	0.0	0.0	0.0
Aug. 7, 1980	37.0	9.2	0.0	0.0	0.0	0.0	0.0
Aug. 8, 1980	43.4	0.6	0.0	0.0	0.0	0.0	0.0
Aug. 9, 1980	19.3	1.0	0.0	0.0	0.0	0.0	0.0
Aug. 10, 1980	47.0	8.0	0.0	0.0	0.0	0.0	0.0
Ave. Aug. 6-10, 1980	34.3	4.4	0.0	0.0	0.0	0.0	0.0

*L = Percentage of natural removal of air pollutants.

⁺ Box A contains the Cabin Creek Mine.



TABLE 6.12
NORTH FORK FLATHEAD RIVER AIRSHED
MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 200 L = 0%*

DATE	A ⁺	Box					
		1	2	3	4	5	6
Nov. 8, 1979	72.4	15.4	3.5	1.8	1.6	6.2	9.5
Nov. 9, 1979	107.7	34.3	3.8	2.3	1.9	7.9	12.5
Nov. 10, 1979	126.0	12.1	4.9	3.0	2.4	10.3	16.4
Nov. 11, 1979	56.4	5.9	1.4	0.8	0.8	2.6	4.0
Nov. 12, 1979	137.2	33.1	5.2	3.0	2.9	10.2	15.8
Ave. Nov. 8-12, 1979	99.9	20.2	3.8	2.2	1.9	7.4	11.6
Nov. 13, 1979	19.2	17.0	0.6	0.5	0.4	1.2	1.5
Nov. 14, 1979	15.7	19.4	1.3	0.1	0.2	0.1	0.4
Nov. 15, 1979	16.4	7.1	0.1	0.1	0.0	0.2	0.4
Nov. 16, 1979	15.5	11.9	0.2	0.2	0.2	0.2	0.0
Nov. 17, 1979	16.7	28.2	2.0	0.7	0.8	0.8	0.1
Ave. Nov. 13-17, 1979	16.7	16.7	0.8	0.3	0.3	0.5	0.5
Aug. 6, 1980	54.1	35.8	1.3	0.8	0.5	2.7	4.3
Aug. 7, 1980	95.5	48.0	3.2	1.8	1.5	6.3	10.2
Aug. 8, 1980	142.4	17.7	4.6	2.8	2.2	9.5	15.2
Aug. 9, 1980	166.8	60.6	12.9	2.9	2.5	9.7	15.2
Aug. 10, 1980	72.8	19.9	3.2	2.2	2.0	6.4	9.2
Ave. Aug. 6-10, 1980	106.3	36.4	5.0	2.1	1.7	6.9	10.8

*L = Percentage of natural removal of air pollutants.

⁺Box A contains the Cabin Creek Mine.



TABLE 6.13
NORTH FORK FLATHEAD RIVER AIRSHED
MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 200 L = 10%*

DATE	Box						
	A ⁺	1	2	3	4	5	6
Nov. 8, 1979	17.3	15.2	0.5	0.4	0.4	1.1	1.4
Nov. 9, 1979	15.3	38.0	1.2	0.1	0.2	0.1	0.0
Nov. 10, 1979	14.7	6.4	0.1	0.1	0.3	0.4	0.0
Nov. 11, 1979	13.9	11.5	0.2	0.2	0.2	0.2	0.0
Nov. 12, 1979	15.0	25.4	1.8	0.6	0.7	0.8	0.1
Ave. Nov. 8-12, 1979	15.2	19.3	0.8	0.3	0.4	0.5	0.3
Nov. 13, 1979	48.7	32.3	1.1	0.7	0.5	3.1	3.9
Nov. 14, 1979	86.0	43.2	2.8	1.7	1.3	5.7	9.0
Nov. 15, 1979	111.5	15.8	4.2	2.5	2.0	8.6	13.7
Nov. 16, 1979	150.1	54.6	11.7	2.5	2.3	8.6	13.8
Nov. 17, 1979	65.6	17.9	2.8	2.0	1.8	5.8	8.4
Ave. Nov. 13-17, 1979	92.4	32.8	4.5	1.9	1.6	6.4	9.8
Aug. 6, 1980	65.2	13.8	3.1	1.7	1.4	5.6	8.5
Aug. 7, 1980	97.0	30.8	3.4	2.1	1.7	7.1	11.2
Aug. 8, 1980	113.4	10.9	4.5	2.6	2.1	9.3	14.8
Aug. 9, 1980	50.9	5.4	1.3	0.7	0.7	2.3	3.6
Aug. 10, 1980	123.6	29.8	4.6	2.8	2.7	9.1	14.2
Ave. Aug. 6-10, 1980	90.0	18.1	3.4	2.0	1.7	6.7	10.5

*L = Percentage of natural removal of air pollutants.

⁺Box A contains the Cabin Creek Mine.



TABLE 6.14
NORTH FORK FLATHEAD RIVER AIRSHED
MULTIPLE BOX MODEL PARTICULATE CONCENTRATIONS

(Values in micrograms per cubic meter)

H = 800 L = 0%*

DATE	Box						
	A ⁺	1	2	3	4	5	6
Nov. 8, 1979	12.8	11.3	0.6	0.5	0.3	0.7	0.7
Nov. 9, 1979	10.5	25.5	1.8	0.1	0.1	0.0	0.0
Nov. 10, 1979	11.0	4.6	0.1	0.0	0.0	0.2	0.2
Nov. 11, 1979	10.2	8.4	0.3	0.4	0.2	0.1	0.0
Nov. 12, 1979	11.1	32.3	8.4	8.9	10.2	3.4	0.0
Ave. Nov. 8-12, 1979	11.1	27.5	2.2	2.0	2.2	0.9	0.2
Nov. 13, 1979	36.0	23.8	0.9	0.4	0.4	1.7	2.0
Nov. 14, 1979	63.7	31.9	2.2	0.9	0.9	3.8	4.7
Nov. 15, 1979	82.4	11.7	3.4	1.3	1.3	5.8	7.0
Nov. 16, 1979	111.1	39.4	14.3	1.6	1.5	6.0	7.0
Nov. 17, 1979	48.5	13.2	2.8	1.8	1.4	5.3	4.3
Ave. Nov. 13-17, 1979	68.3	24.0	4.7	1.2	1.1	4.5	5.0
Aug. 6, 1980	48.2	10.3	3.0	2.3	1.0	3.8	4.4
Aug. 7, 1980	11.8	22.9	2.8	1.3	1.2	4.9	5.8
Aug. 8, 1980	84.0	7.8	3.5	1.5	1.4	6.3	7.6
Aug. 9, 1980	37.6	3.7	1.2	0.5	0.4	1.6	1.9
Aug. 10, 1980	91.5	22.0	4.1	1.9	1.8	6.3	7.2
Ave. Aug. 6-10, 1980	66.6	13.3	2.9	1.5	1.2	4.6	5.4

*L = Percentage of natural removal of air pollutants.

⁺Box A contains the Cabin Creek Mine.



TABLE 6.15
AVERAGE INCREASE IN CONCENTRATION* FOR CASE DAYS

		BOX					
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Particulates							
H = 200	L = 0%	19.9	0.0	0.0	0.0	0.0	0.0
H = 200	L = 10%	19.3	0.0	0.0	0.0	0.0	0.0
H = 800	L = 0%	18.6	0.0	0.0	0.4	0.0	0.0
Sulfur Dioxide							
H = 200	L = 0%	7.1	0.0	0.0	0.0	0.0	0.0

MAXIMUM TWENTY-FOUR HOUR CONCENTRATION* INCREASE FOR CASE DAYS

		BOX					
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Particulates							
H = 200	L = 0%	58.1	10.0	2.9	0.8	10.1	16.0
H = 200	L = 10%	46.3	4.7	0.0	0.0	0.0	0.0
H = 800	L = 0%	33.2	8.7	8.1	9.0	1.3	0.0
Sulfur Dioxide							
H = 200	L = 0%	17.5	0.6	0.0	0.0	0.0	0.0

*Values in micrograms per cubic meter.



TABLE 6.16

NORTH FORK CABIN CREEK MINE

EMISSION PARAMETERS

<u>Source</u>	<u>Sulfur Dioxide (g/sec)</u>	<u>Parti- culates (g/sec)</u>	<u>Stack Height (m)</u>	<u>Diameter (m)</u>	<u>Velocity (m/sec)</u>	<u>Temper- ature (deg K)</u>
Overburden Removal	-	4.42	0	-	-	283
Haul Rocks	-	9.22	0	-	-	283
Wind Erosion	-	13.88	0	-	-	283
Coal Stockpiles	-	2.65	0	-	-	283
Haul Road to Loadout	-	26.01	0	-	-	283
Coal Dryer	21.46	6.06	40	2	90	338

TABLE 6.17

NORTH FORK CABIN CREEK MINE

ANNUAL CONCENTRATION INCREASES

(Values in micrograms per cubic meter)

Sulfur Dioxide			Particulates		
<u>Maximum Predicted</u>	<u>Class I Increment</u>	<u>Class II Increment</u>	<u>Maximum Predicted</u>	<u>Class I Increment</u>	<u>Class II Increment</u>
2.2	2	20	20.2	5	19



In the same North Fork airshed Bison modeled again using the multiple box model and the Valley Model two hypothetical gas flares near Polebridge. The same periods and meteorological data sources as in the coal mine were used in the gas flare models. Table 6.18 lists the emission parameters used in the analysis for both models.

TABLE 6.18

NORTH FORK GAS FLARE

SULFUR DIOXIDE EMISSION PARAMETERS

<u>Source</u>	<u>Emission Rate (g/sec)</u>	<u>Stack Height (m)</u>	<u>Stack Diameter (m)</u>	<u>Gas Velocity (m/sec)</u>	<u>Gas Temperature (deg K)</u>
BN Well	6.80	9	0.4	20.0	1273
Edeburn Well	3.60	9	0.3	20.0	1273

Table 6.19 summarizes the box model results for the 15 days simulated (same periods as previously simulated). The maximum 24-hour concentration predicted was 30.5 ug/m^3 versus the Class I increment of 5 ug/m^3 and the Class II increment of 91 ug/m^3 . Only the box containing the gas flares was predicted to receive impact of sulfur dioxide.

Table 6.20 summarizes the Valley Model results for the two flares. The PSD Class I and II annual increments are also shown for comparison. The location for the maximum was within one kilometer of the source to the south (not in Glacier Park--Class I area). However, the Class II increment is very nearly exceeded using the maximum concentration.



TABLE 6.19

NORTH FORK FLATHEAD RIVER AIRSHED

MULTIPLE BOX MODEL SULFUR DIOXIDE

CONCENTRATIONS - FLARE STACKS

(Values in micrograms per cubic meter)

H = 200_m L = 0%
Box

<u>Date</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Nov. 8, 1979	0	0	0	0	2.75	0
Nov. 9	0	0	0	0	0	0
Nov. 10	0	0	0	0	0.79	0
Nov. 11	0	0	0	0	0	0
Nov. 12	0	0	0	0	0.21	0
Ave. Nov. 8-12, 1979	0	0	0	0	0.75	0
Nov. 13, 1979	0	0	0	0	7.96	0
Nov. 14	0	0	0	0	18.88	0
Nov. 15	0	0	0	0	28.04	0
Nov. 16	0	0	0	0	28.38	0
Nov. 17	0	0	0	0	17.17	0
Ave. Nov. 13-17, 1979	0	0	0	0	20.09	0
Aug. 6, 1980	0	0	0	0	17.67	0
Aug. 7	0	0	0	0	23.17	0
Aug. 8	0	0	0	0	30.54	0
Aug. 9	0	0	0	0	7.38	0
Aug. 10	0	0	0	0	29.29	0
Ave. Aug. 6-10, 1980	0	0	0	0	21.61	0



TABLE 6.20

NORTH FORK FLATHEAD RIVER AIRSHED
VALLEY MODEL ANNUAL SULFUR DIOXIDE
CONCENTRATIONS - FLARE STACKS

(Values in micrograms per cubic meter)

<u>Maximum</u>	<u>Predicted 2nd High</u>	<u>Class I Increment</u>	<u>Class II Increment</u>
19.8	16.5	2	20

6.2 Remaining Airsheds

The remaining five airsheds were modeled using the Industrial Source Complex (ISC) model for both the short-term (24 hours) and long-term (annual) periods. In the runs of the two models for each airshed, the various point and area sources were simulated using the Air Quality Bureau (AQB) emission inventory system (EIS/P&R) and the Flathead River Basin Area Source Emission Inventory.

The models were executed three times in most cases. The preliminary run of the models utilized a two kilometer receptor grid and the large area sources from the Flathead Basin Area Source Inventory (some sources at least six miles on a side). During this model run all receptors were eliminated by the model as they were located too near or within an area source. The first usable run of the models (Run 1 on the following tables) continued to use a two kilometer receptor grid. However, in Run 1 the area sources were broken into one kilometer squares located inside the two kilometer grid. The emission rates were



also scaled upward to account for the reduced area source size.

In Run 2 the locations of the point sources and monitors were plotted on a 7-1/2 minute USGS map as precisely as possible using aerial photographs and available inspection reports. These more accurate locations were then input into the model. Also from the point source emission inventory, all fugitive dust sources determined to be actually area sources not accurately defined as point sources were re-input into the model with the best available area source description.

Table 6.21 shows the results of the Run 1 annual model predictions and the actual monitor results for each airshed. The model varied as to the ratio of predicted to measured but generally under-predicted the actual results. Tables 6.22 through 6.28 list the Run 1 individual results of the short-term model for each airshed and monitor location. Table 6.29 summarizes briefly the results of Tables 6.22 through 6.28. In Table 6.29 the average model prediction was generally below the measured value. Only at the Airport and the Evergreen sites did the model over-predict. The maximum model prediction was generally also below the measured value and also occurred on different days than the measured maxim.

Table 6.30 lists the results of the model predictions and the monitor results for Run 2. No Run 2 was made on the Bigfork airshed as the airshed contained no point sources to be redefined. Model results did change significantly in the Columbia Falls, Polson, and Kalispell airsheds. With the second run the model now under-predicted the concentrations at both Columbia Falls monitor sites. The Anders site prediction dropped



from 391 to 38 ug/m³. The NAAC site concentration predicted showed little change. The Polson site revealed an increase from 20 to 67 ug/m³ compared to the measured of 45 ug/m³. The Universal Athletic site revealed little change. However, the Evergreen site concentration predicted dropped from 274 to 119 ug/m³ whereas the Airport site increased from 16 to 124 ug/m³ compared to the measured value of 61 ug/m³. The sites that had the greatest change generally had fugitive dust sources located nearby.

The Kalispell airshed also was re-modeled using the new source data for the short-term results (Run 2). Tables 6.31 through 6.33 list the individual days modeled. In all cases the models under-predicted the actual concentrations. Section 7 discusses the statistical analyses of these results. Only Kalispell airshed was re-modeled in Run 2 as a test of the new emission source layout. Since the new method did not improve the model results, no further airsheds were simulated.



TABLE 6.21

ANNUAL PARTICULATE CONCENTRATIONS-RUN 1

(Values in micrograms per cubic meter)

<u>Location</u>	<u>Measured</u>	<u>Predicted</u>
Columbia Falls Airshed		
Anders	132	391
NAAC	27	15
Ninepipe Airshed		
Ninepipe	26	1
Polson Airshed		
Polson	45	20
Kalispell Airshed		
Universal Athletic	99	54
Evergreen	-	274
Airport	61	16
Bigfork Airshed		
Bigfork	-	93



TABLE 6.22
COLUMBIA FALLS AIRSHED
ANDERS MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1979	3	89	-
	9	113	105
	15	77	-
	21	68	54
	27	53	298
Feb. 1979	33	79	82
	39	65	23
	45	26	-
	51	18	-
	57	67	-
Mar. 1979	63	147	-
	69	353	-
	75	64	-
	81	231	-
	87	52	2
Apr. 1979	93	-	36
	99	136	33
	105	58	60
	111	245	27
	117	257	84
May 1979	123	82	175
	129	121	27
	135	261	14
	141	375	82
	147	188	-
June 1979	153	176	79
	159	67	46
	165	228	147
	171	200	32
	177	261	-
July 1979	183	88	44
	189	145	49
	195	254	204
	201	175	32
	207	142	40
Aug. 1979	213	210	-
	219	178	35
	225	140	12
	231	87	53
	237	53	-
	243	44	70



TABLE 6.22
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1979	249	238	270
	255	186	5
	261	228	203
	267	279	14
	273	271	47
Oct. 1979	279	484	-
	285	390	-
	291	39	45
	297	42	25
	303	82	20
Nov. 1979	309	67	23
	315	111	21
	321	68	34
	327	100	-
	333	212	-
Dec. 1979	339	37	-
	345	53	-
	351	84	-
	357	36	39
	363	28	-



TABLE 6.23

COLUMBIA FALLS AIRSHED

NAAC MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1979	3	33	-
	9	48	36
	15	42	-
	21	14	7
	27	21	18
Feb. 1979	33	42	6
	39	26	31
	45	50	-
	51	5	-
	57	12	-
Mar. 1979	63	24	-
	69	37	-
	75	16	-
	81	15	-
	87	11	0
Apr. 1979	93	14	14
	99	10	14
	105	8	11
	111	17	7
	117	63	18
May 1979	123	20	22
	129	16	2
	135	27	22
	141	33	11
	147	44	-
June 1979	153	34	13
	159	18	6
	165	35	17
	171	22	7
	177	34	-
July 1979	183	25	12
	189	25	22
	195	26	10
	201	42	8
	207	31	18
Aug. 1979	213	57	-
	219	40	16
	225	40	5
	231	24	7
	237	20	-
	243	13	15



TABLE 6.23
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1979	249	24	57
	255	26	11
	261	43	54
	267	32	52
	273	41	32
Oct. 1979	279	49	-
	285	49	-
	291	18	25
	297	25	35
	303	25	20
Nov. 1979	309	9	10
	315	30	6
	321	60	39
	327	37	-
	333	-	-
Dec. 1979	339	7	-
	345	21	-
	351	56	-
	357	8	22
	363	64	-



TABLE 6.24
NINEPIPE AIRSHED
NINEPIPE MONITOR
TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Mar. 1981	64	8	-
	70	30	1
	76	6	1
	82	10	-
	88	11	1
Apr. 1981	94	11	1
	100	26	-
	106	30	-
	112	8	1
	118	8	-
May 1981	124	25	5
	130	13	-
	136	7	3
	142	19	-
	148	45	2
June 1981	154	24	-
	160	11	1
	166	19	1
	172	17	1
	178	-	2
July 1981	184	-	-
	190	45	2
	196	41	1
	202	45	4
	208	28	3
Aug. 1981	214	45	4
	220	44	-
	226	55	-
	232	38	2
	238	54	-
Sep. 1981	244	55	-
	250	33	-
	256	52	-
	262	42	-
	268	18	1
Oct. 1981	274	13	2
	280	29	-
	286	12	-
	292	25	-
	298	25	1
	304	9	-



TABLE 6.24
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Nov. 1981	310	39	-
	316	-	3
	322	-	0
	328	14	2
	334	6	3
Dec. 1981	340	2	-
	346	12	-
	352	11	-
	358	4	-
	364	17	-
Jan. 1982	5	7	-
	11	20	-
	17	2	-
	23	15	3
	29	4	2
Feb. 1982	35	21	6
	41	26	5
	47	3	1
	53	5	1
	59	9	3



TABLE 6.25

POLSON AIRSHED

POLSON MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Mar. 1981	64	35	-
	70	76	-
	76	13	1
	82	36	-
	88	21	0
Apr. 1981	94	25	0
	100	76	-
	106	59	-
	112	24	1
	118	33	-
May 1981	124	27	1
	130	18	-
	136	11	3
	142	37	-
	148	81	13
June 1981	154	39	-
	160	28	1
	166	36	1
	172	26	1
	178	-	1
July 1981	184	77	8
	190	37	1
	196	40	1
	202	53	1
	208	77	1
Aug. 1981	214	62	-
	220	44	-
	226	83	-
	232	56	1
	238	84	-
Sep. 1981	244	72	-
	250	43	1
	256	51	4
	262	67	7
	268	49	1
Oct. 1981	274	48	1
	280	44	1
	286	37	-
	292	39	-
	298	72	0
	304	35	-



TABLE 6.25
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Nov. 1981	310	174	-
	316	36	1
	322	25	1
	328	26	1
	334	23	-
Dec. 1981	340	15	-
	346	21	-
	352	35	-
	358	16	-
	364	27	-
Jan. 1982	5	36	-
	11	35	-
	17	22	-
	23	34	1
	29	20	1
Feb. 1982	35	53	3
	41	67	1
	47	23	2
	53	61	13
	59	52	8



TABLE 6.26
KALISPELL AIRSHED
AIRPORT MONITOR
TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1980	4	28	83
	10	30	75
	16	45	108
	22	35	66
	28	44	83
Feb. 1980	34	21	107
	40	37	119
	46	29	71
	52	38	88
	58	67	66
Mar. 1980	64	-	47
	70	-	-
	76	13	147
	82	33	89
	88	23	134
Apr. 1980	94	55	73
	100	14	51
	106	12	48
	112	81	94
	118	88	54
May 1980	124	36	52
	130	42	75
	136	-	20
	142	-	56
	148	46	-
June 1980	154	41	84
	160	63	49
	166	33	33
	172	232	61
	178	60	-
July 1980	184	-	57
	190	-	55
	196	27	50
	202	57	59
	208	138	55
Aug. 1980	214	230	30
	220	53	75
	226	72	45
	232	50	108
	238	72	56
	244	56	76



TABLE 6.26
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1980	250	87	57
	256	142	50
	262	63	-
	268	60	27
	274	100	-
Oct. 1980	280	309	95
	286	68	106
	292	47	94
	298	49	118
	304	87	62
Nov. 1980	310	-	-
	316	36	74
	322	78	82
	328	23	60
	334	23	57
Dec. 1980	340	31	98
	346	23	96
	352	45	121
	358	26	124
	364	43	91



TABLE 6.27

KALISPELL AIRSHED

UNIVERSAL ATHLETIC MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1980	4	137	31
	10	55	25
	16	62	83
	22	-	79
	28	123	58
Feb. 1980	34	60	8
	40	63	57
	46	37	40
	52	126	43
	58	-	110
Mar. 1980	64	-	57
	70	-	-
	76	141	5
	82	-	113
	88	197	7
Apr. 1980	94	192	17
	100	59	4
	106	118	26
	112	126	25
	118	87	81
May 1980	124	82	26
	130	107	28
	136	150	43
	142	-	17
	147	138	-
June 1980	154	95	12
	160	66	17
	166	82	23
	172	95	1
	178	68	-
July 1980	184	86	46
	190	112	14
	196	65	32
	202	63	21
	208	137	19
Aug. 1980	214	114	4
	220	-	14
	226	65	38
	232	82	9
	238	71	23
	244	72	24



TABLE 6.27
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1980	250	-	68
	256	202	26
	262	108	-
	268	117	18
	274	-	-
Oct. 1980	280	130	43
	286	73	74
	292	67	46
	298	92	53
	304	91	44
	310	83	-
Nov. 1980	316	85	67
	322	-	95
	328	148	65
	334	52	55
	340	78	2
Dec. 1980	346	48	43
	352	202	82
	358	40	32
	364	296	46



TABLE 6.28
KALISPELL AIRSHED
EVERGREEN MONITOR
TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
May 1980	130	34	88
	136	-	81
	142	-	6
	148	-	-
June 1980	154	32	15
	160	43	125
	166	25	211
	172	91	4
	178	78	-
July 1980	184	81	99
	190	88	24
	196	29	26
	202	55	25
	208	135	83
Aug. 1980	214	100	8
	220	69	190
	226	36	138
	232	32	18
	238	59	174
	244	50	35
Sep. 1980	250	75	73
	256	169	62
	262	62	-
	268	89	126
	274	122	-
Oct. 1980	280	138	46
	286	67	201
	292	49	113
	298	52	127
	304	-	292
Nov. 1980	310	50	-
	316	45	214
	322	89	125
	328	27	295
	334	44	116



TABLE 6.29

COMPARISON OF MODEL PREDICTIONS
WITH MONITOR RESULTS FOR SAMPLING DAYS
(Values in micrograms per cubic meter)

<u>Monitor Location</u>	<u>Average⁺</u>		<u>Maximum</u>	
	<u>Measured</u>	<u>Predicted</u>	<u>Measured</u>	<u>Predicted</u>
Airport	62	75	309*	147*
Univ. Athletic	103	39	296*	113*
Ninepipe	20	2	55*	6*
Polson	45	2	83*	13*
NAAC	30	18	64*	57*
Anders	142	68	484*	298*
Evergreen	68	105	169*	295*
Bigfork	33	0	109	0

*Occurred on different days.

+Average concentration for days that were modelled.



TABLE 6.30

ANNUAL PARTICULATE CONCENTRATIONS-RUN 2

(Values in micrograms per cubic meter)

<u>Location</u>	<u>Measured</u>	<u>Predicted</u>
Columbia Falls Airshed		
Anders	132	38
NAAC	27	12
Ninepipe Airshed		
Ninepipe	26	1
Polson Airshed		
Polson	45	67
Kalispell Airshed		
Universal Athletic	99	65
Evergreen	-	119
Airport	61	124



TABLE 6.31

KALISPELL AIRSHED-RUN 2

AIRPORT MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1980	4	28	4
	10	30	1
	16	45	7
	22	35	4
	28	44	3
Feb. 1980	34	21	2
	40	37	1
	46	29	1
	52	38	3
	58	67	1
Mar. 1980	64	-	-
	70	-	-
	76	13	3
	82	33	1
	88	23	2
Aprl 1980	94	55	0
	100	14	0
	106	12	1
	112	81	1
	118	88	1
May 1980	124	36	2
	130	42	1
	136	-	-
	142	-	-
	148	46	-
June 1980	154	41	1
	160	63	1
	166	33	0
	172	232	1
	178	60	-
July 1980	184	-	-
	190	-	-
	196	27	1
	202	57	1
	208	138	1
Aug. 1980	214	230	1
	220	53	1
	226	72	1
	232	50	5
	238	72	4
	244	56	1



TABLE 6.31
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1980	250	87	4
	256	142	1
	262	63	-
	268	60	2
	274	100	-
	280	309	8
Oct. 1980	286	68	2
	292	47	2
	298	49	4
	304	87	1
	310	-	-
Nov. 1980	316	36	3
	322	78	2
	328	23	1
	334	23	0
	340	31	5
Dec. 1980	346	23	5
	352	45	3
	358	26	2
	364	43	2



TABLE 6.32

KALISPELL AIRSHED-RUN 2

EVERGREEN MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
May 1980	130	34	1
	136	-	1
	142	-	6
	148	-	-
June 1980	154	32	0
	160	43	0
	166	25	0
	172	91	1
July 1980	178	78	-
	184	81	2
	190	88	0
	196	29	6
Aug. 1980	202	55	3
	208	135	0
	214	100	17
	220	69	7
Sep. 1980	226	36	0
	232	32	12
	238	59	0
	244	50	0
Oct. 1980	250	75	1
	256	169	5
	262	62	-
	268	89	4
Nov. 1980	274	122	-
	280	138	10
	286	67	1
	292	49	25
	298	52	2
	304	-	292
	310	50	-
	316	45	16
	322	89	4
	328	27	0
	334	44	15



TABLE 6.33

KALISPELL AIRSHED-RUN 2

UNIVERSAL ATHLETIC MONITOR

TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Jan. 1980	4	137	5
	10	55	1
	16	62	25
	22	-	-
	28	123	4
Feb. 1980	34	60	0
	40	63	7
	46	37	3
	52	126	7
	58	-	-
Mar. 1980	64	-	-
	70	-	-
	76	141	0
	82	-	-
	88	197	0
Apr. 1980	94	192	0
	100	59	0
	106	118	5
	112	126	1
	118	87	8
May 1980	124	82	1
	130	107	6
	136	150	0
	142	-	-
	147	138	-
June 1980	154	95	4
	160	66	2
	166	82	9
	172	95	0
	178	68	-
July 1980	184	86	9
	190	112	1
	196	65	1
	202	63	5
	208	137	28
Aug. 1980	214	114	0
	220	-	-
	226	65	12
	232	82	0
	238	71	1
	244	72	15



TABLE 6.33
(Cont.)

	<u>Julian Day</u>	<u>Measured</u>	<u>Predicted</u>
Sep. 1980	250	-	-
	256	202	2
	262	108	-
	268	117	0
	274	-	-
Oct. 1980	280	130	3
	286	73	6
	292	67	23
	298	92	3
	304	91	9
Nov. 1980	310	83	-
	316	85	5
	322	-	-
	328	148	18
	334	52	3
Dec. 1980	340	78	0
	346	48	5
	352	202	10
	358	40	9
	364	296	2



7.0 MODEL EVALUATION

The airshed model results for the first and second runs of the models were evaluated using several different methods to evaluate the model performance. Both the long-term and short-term model results were evaluated. Tables 7.1 through 7.4 summarize the model evaluations for the various monitor locations. In Table 7.1 the model accuracy for the annual particulate concentrations is listed. The residual is defined as the measured or observed minus the predicted. In Table 7.1 all but two residuals are positive for Run 1 varying from 12 at NAAC to 45 at the Airport and Universal Athletics monitor locations. At the Anders location the residual was -259 and at Bigfork -100. In the second run at several sites the residuals reversed signs and the overall average residual appeared better. Table 7.2 summarizes the accuracy for the short-term model results. Two evaluations are present--the accuracy based on space and time and the accuracy based on space only. Shown in Table 7.2 are the maximum and second high concentration residuals. The space and time residuals varied greatly from location to location. The worst residuals were at the Anders location (maximum = 293) in the first run and at the Airport in the second run (maximum = 301). The best residuals were at the NAAC (maximum = 45) and Ninepipe (maximum = 43) location. Using the space only residuals the result does not change appreciably except at the Evergreen site. Only the Evergreen site made a change from positive to negative residual for both maximum and second high. The



residuals for Bigfork are misleading as the model never predicted above 0.01 ug/m^3 . The residuals are simply the measured value minus zero.

Table 7.3 summarizes the precision or performance measure for gross variability. Shown in Table 7.3 are both the mean absolute residual and the mean square error. The mean absolute residuals varied from 98 at Universal Athletic to 14 at NAAC. The mean square error analysis revealed very high values. Results varied from a low of 320 at NAAC to a high of 15,768 at the Airport. No results are shown for Bigfork as the numbers are meaningless based upon the discussion in the previous paragraph.

The evaluation of the short-term model results also included use of the Student's "t" test. As a test of randomness the residuals were subjected to a "Runs" test. Table 7.4 summarizes the Runs test and the Student's "t" test. The Runs test failed on the Polson site indicating the variance of the residual about the mean was not random. The remaining sites passed the Runs test. Table 7.4 also lists the degrees of freedom, the "t" values, and the critical "t" values. In the case of the "t" test, the null hypothesis would be that the mean of the predicted values is equal to the mean of the measured values. If the "t" value calculated is greater than the critical "t" value, the null hypothesis must be rejected. In all cases the null hypothesis is rejected. Only for the Evergreen and Airport sites on the first run were the "t" values close to not being rejected.

The final evaluation of the short-term model results was performed by calculation of a linear regression and correlation



coefficient for the measured versus predicted values. Table 7.5 summarizes the regression coefficients and the correlation coefficients. The correlations ranged from -0.31 at Evergreen to 0.52 at Polson. The Polson, Ninepipe, and Columbia Falls airshed models appeared to predict the best based on the correlation coefficient. The second run on the Kalispell airshed improved the correlation for the Evergreen and Airport sites.



TABLE 7.1
RESIDUAL MEASURE OF ACCURACY
ANNUAL CONCENTRATIONS

<u>Monitor Location</u>	<u>Residual-Run 1</u>	<u>Residual-Run 2</u>
Anders	-259	94
NAAC	12	15
Ninepipe	25	25
Polson	25	-22
Univ. Athletic	45	34
Airport	45	-63
Bigfork	-100	--



TABLE 7.2
RESIDUAL MEASURE OF ACCURACY
TWENTY-FOUR HOUR CONCENTRATIONS

<u>Monitor Location</u>	<u>Space</u> <u>Maximum</u>	<u>and Time</u> <u>2nd High</u>	<u>Space</u> <u>Maximum</u>	<u>2nd High</u>
Anders	293	265	77	9
NAAC	45	21	6	6
Ninepipe	43	41	50	49
Polson	68	76	70	68
Univ. Athletic - Run 1	250	176	183	92
Airport - Run 1	214	171	162	98
Evergreen - Run 1	107	92	-126	-154
Bigfork	109	84	109	84
Univ. Athletic - Run 2	294	200	268	177
Airport - Run 2	301	231	301	225
Evergreen - Run 2	164	128	144	121



TABLE 7.3

PERFORMANCE MEASURE FOR GROSS VARIABILITY
TWENTY-FOUR HOUR PARTICULATE CONCENTRATIONS

<u>Monitor Location</u>	<u>Mean Absolute Residual</u>	<u>Mean Square Error (MSE_d)</u>
Anders	95	15,768
NAAC	14	320
Ninepipe	18	510
Polson	40	1,918
Univ. Athletics - Run 1	71	7,853
Airport - Run 1	53	4,975
Evergreen - Run 1	79	10,007
Univ. Athletics - Run 2	98	12,226
Airport - Run 2	60	6,740
Evergreen - Run 2	62	5,170



TABLE 7.4
STUDENT'S "t" TEST RESULTS

<u>Monitor Location</u>	N	Runs Test		Deg. Freedom	T	<u>T_{critical}</u>
		Passes	Pass/Fail			
Anders	39	18	Pass	76	4.071	1.995
NAAC	40	19	Pass	78	2.910	1.994
Ninepipe	29	11	Pass	56	6.769	2.004
Polson	40	9	Fail	78	--	--
Airport - Run 1	50	20	Pass	98	2.079	1.987
Univ. Athletic - Run 1	47	24	Pass	92	8.365	1.989
Evergreen - Run 1	27	9	Pass	52	2.041	2.011
Airport - Run 2	50	22	Pass	98	7.287	1.987
Univ. Athletic - Run 2	47	20	Pass	92	12.850	1.989
Evergreen - Run 2	27	8	Pass	52	8.437	2.011



TABLE 7.5
LINEAR REGRESSION AND CORRELATION

<u>Site</u>	<u>a*</u>	<u>b*</u>	<u>r</u>
Anders	0.195	128.700	0.16
NAAC	21.359	0.314	0.33
Evergreen - Run 1	83.500	-0.150	-0.31
Polson	35.050	3.003	0.52
U. Ath. - Run 1	102.170	0.029	0.01
Ninepipe	14.570	2.630	0.27
Airport - Run 1	97.660	-0.469	-0.23
Bigfork	0.000	33.000	0.00
Evergreen - Run 2	66.075	0.144	0.03
U. Ath. - Run 2	107.502	-0.793	-0.10
Airport - Run 2	6.058	48.717	0.18

*Where predicted = a x observed + b



8.0 SUMMARY

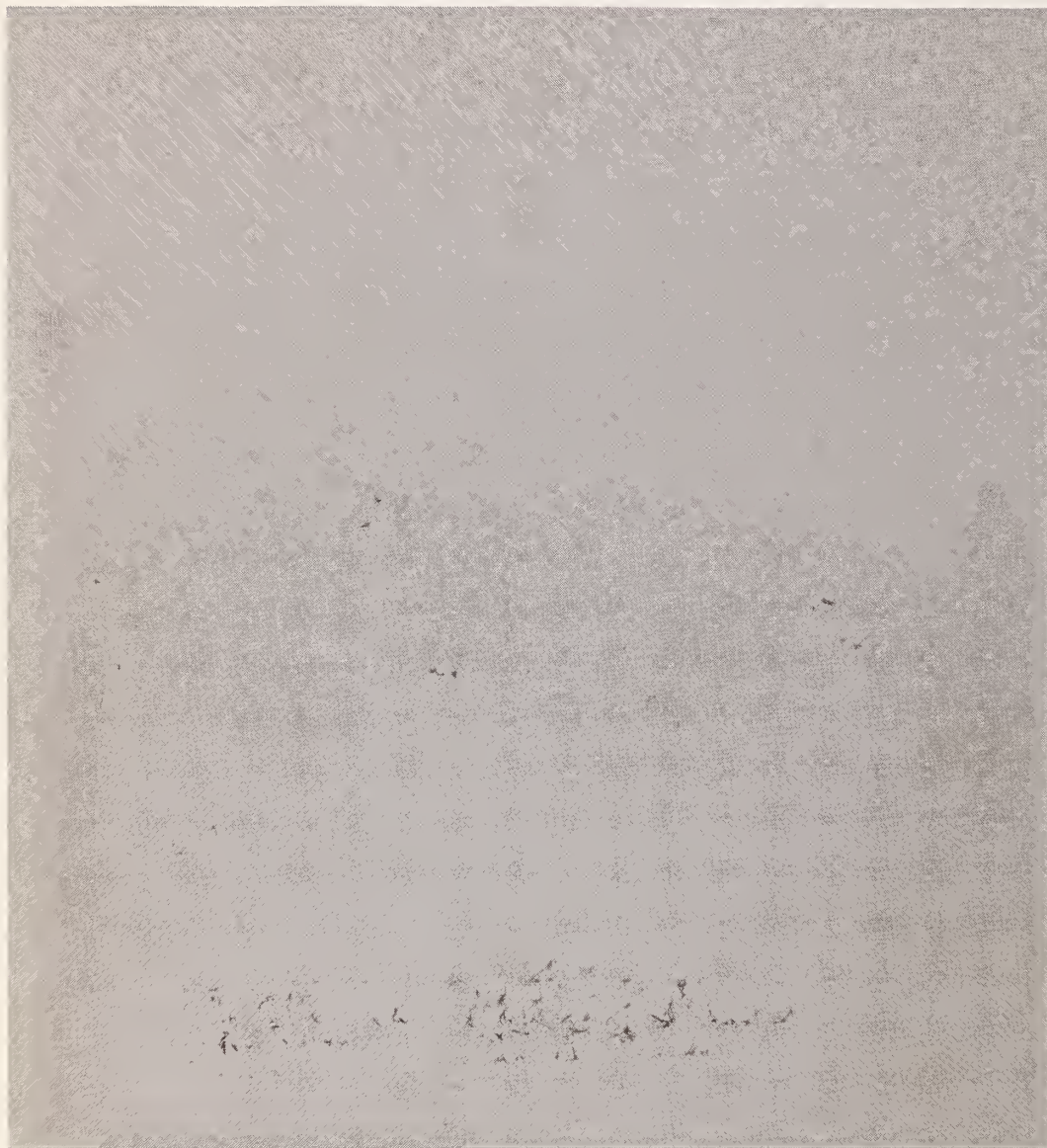
The air quality modeling analysis despite the problems with the model versus monitor comparisons, provided a valuable analysis. The meteorological and air quality data collected over the life of the Flathead River Basin Environmental Impact Study was compiled, audited and the best data periods assembled in diffusion model compatible data sets. The emission inventory data was also verified and assembled in diffusion model compatible files. Six distinct airsheds in the basin were designated and the appropriate meteorology and emission data assigned to each airshed. Various modeling runs were made with varying degrees of success. The models used in the North Fork of the Flathead River (Box model and VALLEY model) agreed fairly well with monitor results. However, the ISC model used in the major portion of the analysis did not predict as well. The annual ISC models did compare reasonably well with the monitor results. In the Run 2 results the model generally under-predicted the actual concentrations. The most likely cause of the under-prediction probably was the area source emission inventory did not adequately describe the magnitude of the emissions especially for sources very near the monitor locations. The short-term model results varied much more than the long-term results. However, again the models generally under-predicted the present concentrations. The data bases and models prepared under this analysis will be very helpful in assessing the impact of new or modified air pollution sources. However, the models will not



replace the need for pre- and post-construction monitoring.

Other models could have been tested on the emission and meteorological data if additional time and funds had been available. However, because of the complex airflow and the variety of emission sources in the basin it is doubtful that any EPA or non-EPA model would have performed better than ISC. The degree of sophistication of diffusion models available and the limited number of meteorological monitoring sites limit the accuracy of the predictions especially in complex airflow regions such as the Flathead Basin.





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